START

0038169

FEB 14 1994

Sta 10

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 601627

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Remediated Waste Projects 24700	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: W-296	6. Cog. Engr.: M. A. Casbon	7. Purchase Order No.: N/A
8. Originator Remarks: This EDT transmits the Trench Operations Sequence Engineering Study for release. The study was prepared by Golder Associates for Remediated Waste Projects.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: ERDF
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-W296-ES-01		0	Trench Operations Sequence Engineering Study	4	2	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.
4, 2	1	Cog.Eng. M. A. Casbon A5-56 M. A. Casbon 1/27/94			
4, 2	1	Cog. Mgr. V. R. Dronen A5-56 V. R. Dronen 1/27/94			
		QA			
		Safety			
		Env.			

SEP 1994 RECEIVED EDMC

18. M. A. Casbon 1/27/94 Signature of EDT Originator Date	19. Authorized Representative Date for Receiving Organization	20. 1/27/94 Cognizant/Project Engineer's Manager Date	21. DOE APPROVAL (if required) Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-1 (07/91)

THIS PAGE INTENTIONALLY
LEFT BLANK

ORIGINAL

Date Received: 1-7-94 cw	INFORMATION RELEASE REQUEST	Reference: WHC-CM-3-4

Complete for all Types of Release

Purpose		ID Number (include revision, volume, etc.)
[] Speech or Presentation	[] Reference	WHC-SD-W296-ES-01, Rev. 0
[] Full Paper (Check only one suffix)	[x] Technical Report	List attachments.
[] Summary	[] Thesis or Dissertation	N/A
[] Abstract	[] Manual	
[] Visual Aid	[] Brochure/Flier	
[] Speakers Bureau	[] Software/Database	Date Release Required
[] Poster Session	[] Controlled Document	1/14/93
[] Videotape	[] Other	

Title Trench Operations Sequence Engineering Study	Unclassified Category UC-	Impact Level 4

New or novel (patentable) subject matter? [X] No [] Yes If "Yes", has disclosure been submitted by WHC or other company? [] No [] Yes Disclosure No(s).	Information received from others in confidence, such as proprietary data, trade secrets, and/or inventions? [X] No [] Yes (Identify)
Copyrights? [X] No [] Yes If "Yes", has written permission been granted? [] No [] Yes (Attach Permission)	Trademarks? [X] No [] Yes (Identify)

Complete for Speech or Presentation

Title of Conference or Meeting N/A		Group or Society Sponsoring N/A
Date(s) of Conference or Meeting	City/State	Will proceedings be published? [] Yes [X] No Will material be handed out? [] Yes [X] No

Title of Journal

CHECKLIST FOR SIGNATORIES

Review Required per WHC-CM-3-4	Yes	No	Reviewer - Signature Indicates Approval Name (printed)	Signature	Date
Classification/Unclassified Controlled Nuclear Information	[]	[x]			
Patent - General Counsel	[x]	[]	S W Bergin	[signature]	1/12/94
Legal - General Counsel	[x]	[]			
Applied Technology/Export Controlled Information or International Program	[]	[x]			
WHC Program/Project	[x]	[]	V. R. Dronen	See below for signature	1-5-94
Communications	[]	[x]			
RL Program/Project	[x]	[]	M. S. Collins	[signature]	3 Jan 94
Publication Services	[x]	[]	Kim Lickenla Clearance Review Only		1/5/94
Other Program/Project	[]	[x]			

Information conforms to all applicable requirements. The above information is certified to be correct.

	Yes	No
References Available to Intended Audience	[x]	[]
Transmit to DOE-HQ/Office of Scientific and Technical Information	[]	[x]

Author/Requestor (Printed/Signature) Date

M. A. Casbon [signature]

Intended Audience

[] Internal [] Sponsor [X] External

Responsible Manager (Printed/Signature) Date

V. R. Dronen [signature] 1/5/94

INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP

Stamp is required before release. Release is contingent upon resolution of mandatory comments.

APPROVED FOR RELEASE
OFFICIAL DOCUMENT
cw
Date 1-18-94

Date Cancelled	Date Disapproved

THIS PAGE INTENTIONALLY
LEFT BLANK

SUPPORTING DOCUMENT

1. Total Pages ~~112~~ 114

2. Title
Trench Operations Sequence Engineering Study

3. Number
WHC-SD-W296-es-01

4. Rev No.
0

5. Key Words
Project W-296, Environmental Restoration Disposal Facility (ERDF), Slope Stability, Leachate Generation Rates, Interim cover, Liner System, Trench, Stacking Plan.

6. Author
Name: M. A. Casbon

M. A. Casbon
Signature

Organization/Charge Code 24700/J247A

7. Abstract

This document evaluates several aspects of trench operation for the ERDF. These aspects include: waste and liner slope stability, a filling plan based on stability considerations, and the need for a low permeability interim cover.

9. Impact Level 4

10. RELEASE STAMP

OFFICIAL RELEASE 23
BY WHC
DATE FEB 11 1994
Sta #10

THIS PAGE INTENTIONALLY
LEFT BLANK

TRENCH OPERATIONS SEQUENCE ENGINEERING STUDY

THIS PAGE INTENTIONALLY
LEFT BLANK

CONTENTS

CONTENTS (Cont.)

FIGURES (cont):

TRENCH OPERATIONS SEQUENCE ENGINEERING STUDY FOR THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

1.0 INTRODUCTION

The production of plutonium and related activities since 1943 have resulted in significant environmental (primarily soil) contamination on the Hanford site. The Environmental Restoration Disposal Facility (ERDF) will serve as the disposal facility for the majority of wastes excavated during remediation of waste management sites in the 100, 200, and 300 areas of the Hanford facility. The initial work was designated by Westinghouse Hanford Company (WHC) as Project W-296, and is defined as the design and construction of facilities for the disposal of waste generated through the year 2001. Only waste from the 100 and 300 Areas will be disposed of in W-296.

The disposal facility itself is planned as a single large trench (landfill), referred to as the area fill trench. The trench will be approximately 9,000 feet long, 1,000 feet wide at the floor, and 70 feet deep, with 3H:1V (horizontal:vertical) sideslopes. It will be lined with a double liner system to comply with RCRA Subtitle C requirements for hazardous waste landfills. The sideslope liner system will consist of a 3-ft-thick low-permeability soil/bentonite admix layer placed directly on the native soils, overlain by a synthetic secondary geomembrane and geocomposite drainage layer, and a synthetic primary geomembrane and geocomposite drainage layer. The liner system will then be protected by a 3-ft-thick native soil operations layer. The base liner system will be identical, with the exception that the geocomposite drainage synthetics will be replaced by gravel drainage layers. The configuration of the liner system is shown on Figure 1-1, and is described in more detail in COE 1993a.

This study evaluates several aspects of trench operation. Stability considerations to prevent failure through the waste, liner, or subgrade are evaluated in Section 2.0. Based on these considerations, a general filling plan is described in Section 3.0. The need for a low-permeability cover over the filled portions of the landfill is discussed in Section 4.0.

THIS PAGE INTENTIONALLY LEFT BLANK

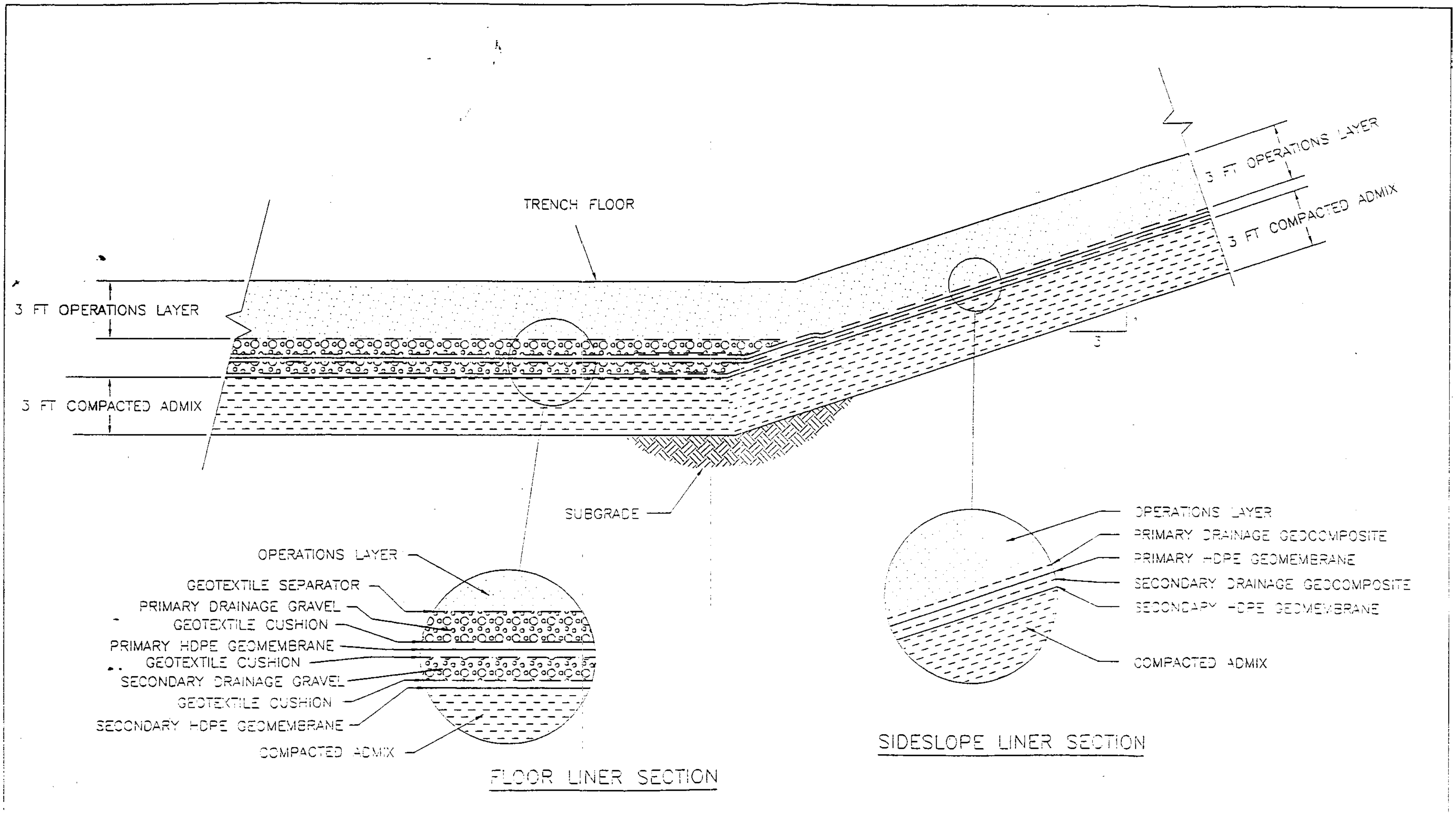


Figure 1-1. ERDF Liner System Section

THIS PAGE INTENTIONALLY
LEFT BLANK

2.0 STABILITY CONSIDERATIONS

The allowable configurations of waste and access ramps within the trench are constrained by the requirement to avoid instabilities of any sort within the waste, liner system, or subgrade. Ultimately, with the trench filled, there will be no potential for instabilities of any sort except for minimal subsidence associated with ongoing settlement of the waste (COE 1993a). During the filling operations, however, sliding within and through the liner system is possible under the influence of both unbalanced static loads and dynamic earthquake loads. Stability constraints are evaluated below through use of conventional methods of stability analysis.

2.1 FAILURE MODES

Failure modes to be considered during the operational stage include the following (Figure 2-1):

- Sideslope subgrade failures (Figure 2-1 (a)).
- Liner failures prior to waste placement (e.g., slippage of the operations layer, Figure 2-1 (b)).
- Failure of the waste either entirely through the waste (Figure 2-1 (c)) or partially through waste and partially along the liner system (Figure 2-1 (d); this includes both two-dimensional failures and three-dimensional wedge failures).
- Failure of waste (Figure 2-1 (e)) entirely along the liner system.

Stability must be considered under both static and dynamic loading conditions. Static stability will be ensured by the use of defensible material strengths together with a factor of safety of 1.5. Dynamic stability will be conservatively achieved by the use of a seismic coefficient of 0.12g (DOE 1989) and a pseudo-static factor of safety of 1.1. The use of these factors of safety is consistent with industry practice and standards for geotechnical engineering. This approach has also been used for the Project W-025 Landfill, which has a very similar lining system and is presently under construction in the 200 West Area of the Hanford Site (Golder Associates Inc. 1992).

2.2 MATERIAL STRENGTHS

There are a variety of materials and interfaces to be considered, depending on the failure mode being evaluated. Because the ERDF is in the early stages of design, site characterization has not been completed and material specifications have not been developed. However, this type of data has been developed for the Project W-025 Landfill. Because the liner system and subgrade conditions for the ERDF are expected to be similar to those at Project W-025, strength values should also be similar. The following data were used for this study:

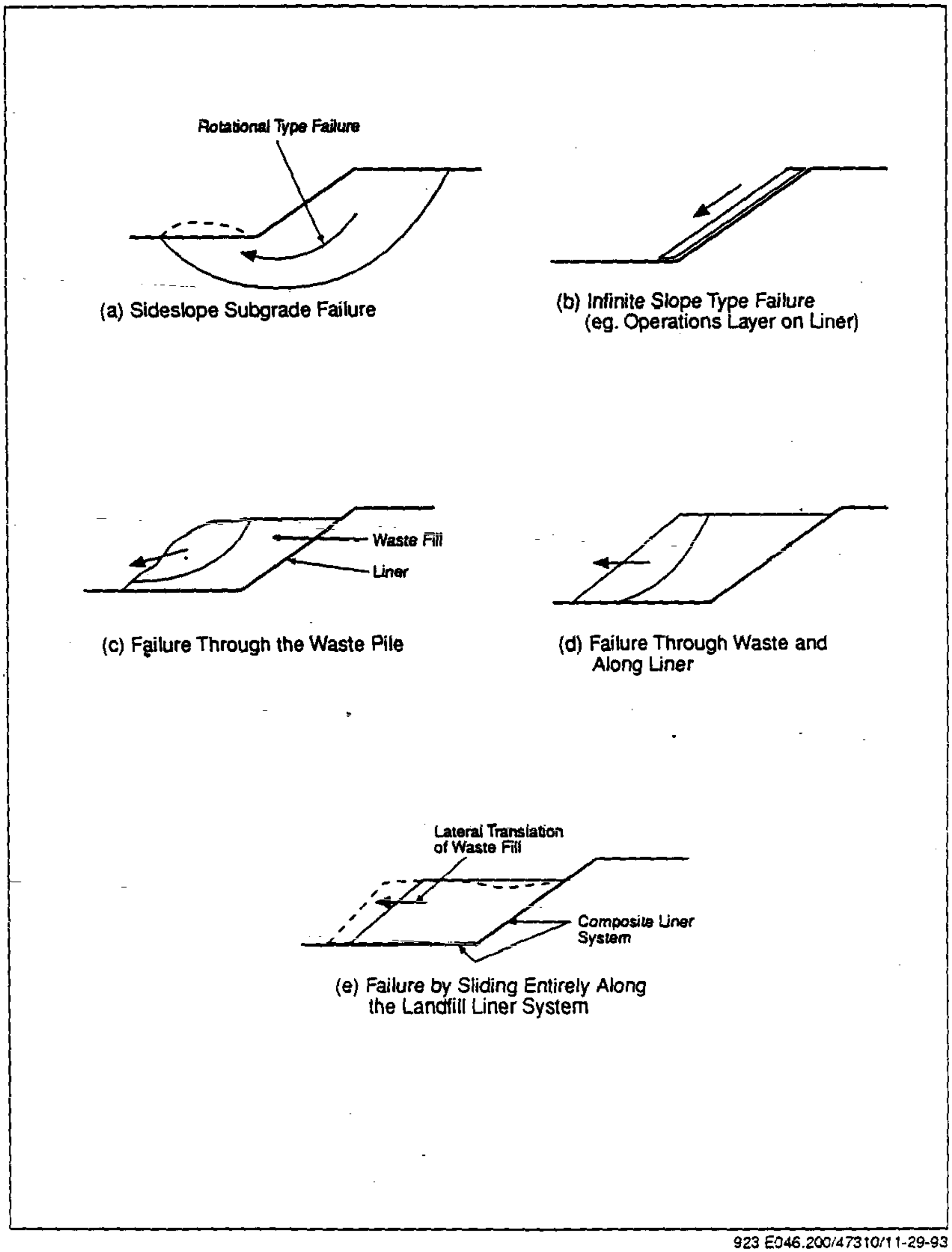


Figure 2-1. Schematic Diagrams of Potential Failure Modes.

- Subgrade:

  - Cohesion = 0
  - Friction Angle = 38 degrees
  - Source: laboratory testing (Golder Associates Inc. 1989)

- Liner Admix:

  - Cohesion = 0
  - Friction Angle = 36 degrees
  - Source: laboratory testing (Golder Associates Inc. 1992)

- Admix/Textured Geomembrane Interface:

  - Cohesion = 0
  - Friction Angle = 27.5 degrees
  - Source: required by Project W-025 specifications (Golder Associates Inc. 1993) based on engineering analysis

- Operations Layer:

  - Cohesion = 0
  - Friction Angle = 36 degrees
  - Source: laboratory testing (Golder Associates Inc. 1992)

- Operations Layer/Geocomposite Interface:

  - Cohesion = 0
  - Friction Angle = 27.5 degrees
  - Source: required by Project W-025 specifications (Golder Associates Inc. 1993) based on engineering analysis

- Geocomposite/Textured Membrane Interface:

  - Cohesion = 0
  - Friction Angle = 27.5 degrees
  - Source: required by Project W-025 specifications (Golder Associates Inc. 1993) based on engineering analysis

The above strength for the Geocomposite/Textured Geomembrane interface represents achievable peak strength which can be relied upon at relatively low levels of normal stress typical of that which will be applied by the operations layer on the trench sideslopes, i.e., a few hundred pounds per square foot. At higher normal stress levels, the strength of this interface is considered to be more complex.

At high normal stresses, the load-deformation behavior of textured geomembranes and geocomposites exhibits strain-weakening or strain-softening behavior. This has been shown in large shear box (e.g., 12-in. square) direct shear testing, where peak friction angles of 25° to 30° are indicated for shear displacements of a few tenths of an inch. With ongoing shear displacement, however, the strength decreases as the fibers of the geotextile are progressively broken and plucked from the geotextile. At interface shear displacements on the order of 1.5 to 2 in., which represents the limit of travel for most large shear boxes, the interface shear strength has typically reduced to a friction angle of 16° to 20°. Recent testing of several textured geomembrane/geotextile interfaces in a ring shear apparatus, which has the ability to achieve very large interface shear deformations, has indicated that true residual strengths can approach typically 12° to 14°, at relative shear displacements in excess of one foot. It should be assumed at this stage of design that similar behavior would be exhibited by the textured geomembrane/geocomposite interface in the ERDF. Accordingly, along the flat base of the liner system, the available shear strength was assumed to be given by a friction angle of 20°. Along the 3H:1V base sideslopes, where settlements during construction will tend to mobilize higher shear stresses, there is the potential for slippage and for the interface shear displacements to extend well into the post-peak range. The tendency for this behavior will depend on factors such as the angle of the sideslope, the specific weight and compressibility of the waste, and the ultimate depth of the waste. The area fill trench exhibits generally favorable characteristics in this regard because of the relatively flat 3H:1V sideslopes, the presumed stiff character of the waste as a result of the planned compaction to reduce settlements of the final cap, and the limited height of the waste. However, it was assumed that residual-type friction angles can be mobilized beneath the sideslopes along the geomembrane/geocomposite interface, and consequently a friction angle of 14° has been use in this analysis.

- Waste:

  - Cohesion = 0
  - Friction Angle = 30 degrees
  - Source: conservative assumption for compacted granular fill

2.3 STABILITY EVALUATION

Stability analyses reported below have been performed using the computer program XSTABL (Sharma 1991), employing the modified Janbu method of slices. Where appropriate, an analytical solution for the simplified infinite slope problem has also been used.

2.3.1 Sideslope Subgrade Failures

The stability of the 3H:1V subgrade slopes has been previously evaluated (Golder Associates Inc. 1992). For a subgrade strength characterized by a friction angle of 38°, the static factor of safety is 2.3 and the computed pseudostatic factor of safety for an equivalent horizontal acceleration of 0.12g is 1.7. These values indicate that there is no concern with either static or seismic stability for 3H:1V cut slopes within the subgrade.

2.3.2 Liner/Operations Layer Sideslope Sliding

Following construction of the sideslope and placement of the protective operations layer, there is the potential for sliding within either the operations layer or the liner admix, or at one of the liner interfaces. Such failures can be conservatively analyzed by assuming an infinite slope model, with sliding parallel to the face of the slope. As noted above, the critical interface strength at these low normal stress levels is considered to be represented by a friction angle of 27.5°. The calculated static factor of safety for a 3H:1V sideslope with a strength of 27.5° is 1.6, and the corresponding pseudostatic factor of safety for an equivalent horizontal acceleration of 0.12g is 1.1. These values indicate no static or dynamic stability concerns with the liner sideslopes, prior to the placement of waste upon those sideslopes.

2.3.3 Waste Operational Slopes

Maximum allowable waste slope angles at the operational face during construction will be determined by consideration of the stability of (1) slips which are contained entirely within the waste, or (2) bilinear slips passing partially through the waste and partially along a weak interface in the basal liner system. For thin sliver (infinite slope) failures on the face of the waste slope, static factors of safety are calculated at 1.7 for a waste slope angle of 3H:1V and a waste friction angle of 30°. The corresponding pseudostatic factor of safety with an applied equivalent horizontal acceleration of 0.12g is 1.2. More deep seated slips contained entirely within the waste will exhibit higher static and pseudostatic factors of safety.

For bilinear failures through the waste and along the geomembrane/geocomposite interface (friction angle of 20°), the calculated minimum static factor of safety for a 3H:1V slope is 1.6, and the corresponding pseudostatic factor of safety for an applied 0.12g equivalent horizontal acceleration is 1.1 (Analyses A1 and A2 in Appendix A). These analyses indicate that operational slopes within the waste can be safely constructed at angles up to 3H:1V.

Operational slopes will also be constructed above the trench sideslopes (i.e., an active waste slope with a dip direction parallel to the strike of the trench sideslope). As noted in Section 2.2, there is the potential for relatively large strains to occur at the geocomposite/textured geomembrane interface on the trench sideslopes during construction, thereby reducing available strengths closer to residual friction angles of about 14°. However, this relatively low interface strength will apply in the down-dip direction of the trench slope, and strengths along the strike of the trench slope are of primary interest for operational slope stability. The along-strike shear strength has been assumed to correspond to a friction angle of 20°, although this will need to be carefully evaluated by appropriate strength testing. A basal friction angle of 20° will enable static factors of safety of 1.6 and pseudostatic factors of safety (0.12g applied equivalent acceleration) of 1.1 to be achieved with waste operational slope angles of 3H:1V, as noted above. If this interface strength cannot be demonstrated, then operational waste slopes located above the trench sideslopes might need to be flattened somewhat.

2.3.4 Waste Slips Along Liner

During the initial stages of the development of the landfill, consideration must also be given to failure mechanisms which involve sliding of the waste entirely along the liner system. In general, as development proceeds away from the trench sideslopes, this failure mode will become less important because the waste located above the 3H:1V sideslope will be buttressed by increasing quantities of waste located above the base of the trench. During initial filling, however, care must be exercised to maintain sufficient buttressing waste above the trench base in order to support that waste which is located above the trench sideslopes.

The critical interface strength along the base of the trench has been characterized by a friction angle of 20°, and the strength in the downslope direction of the trench sideslope by a friction angle of 14°, as previously noted. For a configuration in which the volume of waste located above the trench base is equivalent to the volume of waste located above the trench sideslope, the static factor of safety is calculated to be 1.9 and the pseudostatic factor of safety with an applied equivalent horizontal acceleration of 0.12g is calculated to be 1.1 (Analyses A3 and A4 in Appendix A). These analyses indicate that such a configuration would exhibit satisfactory stability under both static and dynamic loading conditions.

2.4 STABILITY CONSTRAINTS ON WASTE CONFIGURATIONS

The stability analyses performed for this study indicate the following:

- Sideslopes of 3H:1V can be excavated in the subgrade.
- The proposed liner with operations layer can be constructed on these 3H:1V sideslopes.
- Overall operational slopes within the waste should be limited to 3H:1V. Where these slopes are located above the trench sideslopes, somewhat flatter waste slope angles might be required depending on the results of strength testing.
- Where waste is located above the trench sideslopes, it should at all times during the operation be buttressed by at least an equivalent quantity of waste located above the flat base of the trench.

3.0 CONCEPTUAL FILL PLAN

A major aspect of trench operation is the sequence and geometry used for placing waste in the trench. There are several requirements to be satisfied by the operations (filling) sequence ultimately adopted.

- First, there must be adequate working space available to permit hauling, waste placement, and compaction equipment to operate; trench and liner construction and interim cover operations to proceed; and decontamination operations to occur simultaneously and without interference.

- Second, the sequence adopted should limit the amount of liner, interim cover, and trench preparation required to accept each annual waste load and at the same time enable easy transition from one phase of trench and liner construction and waste placement to the next.

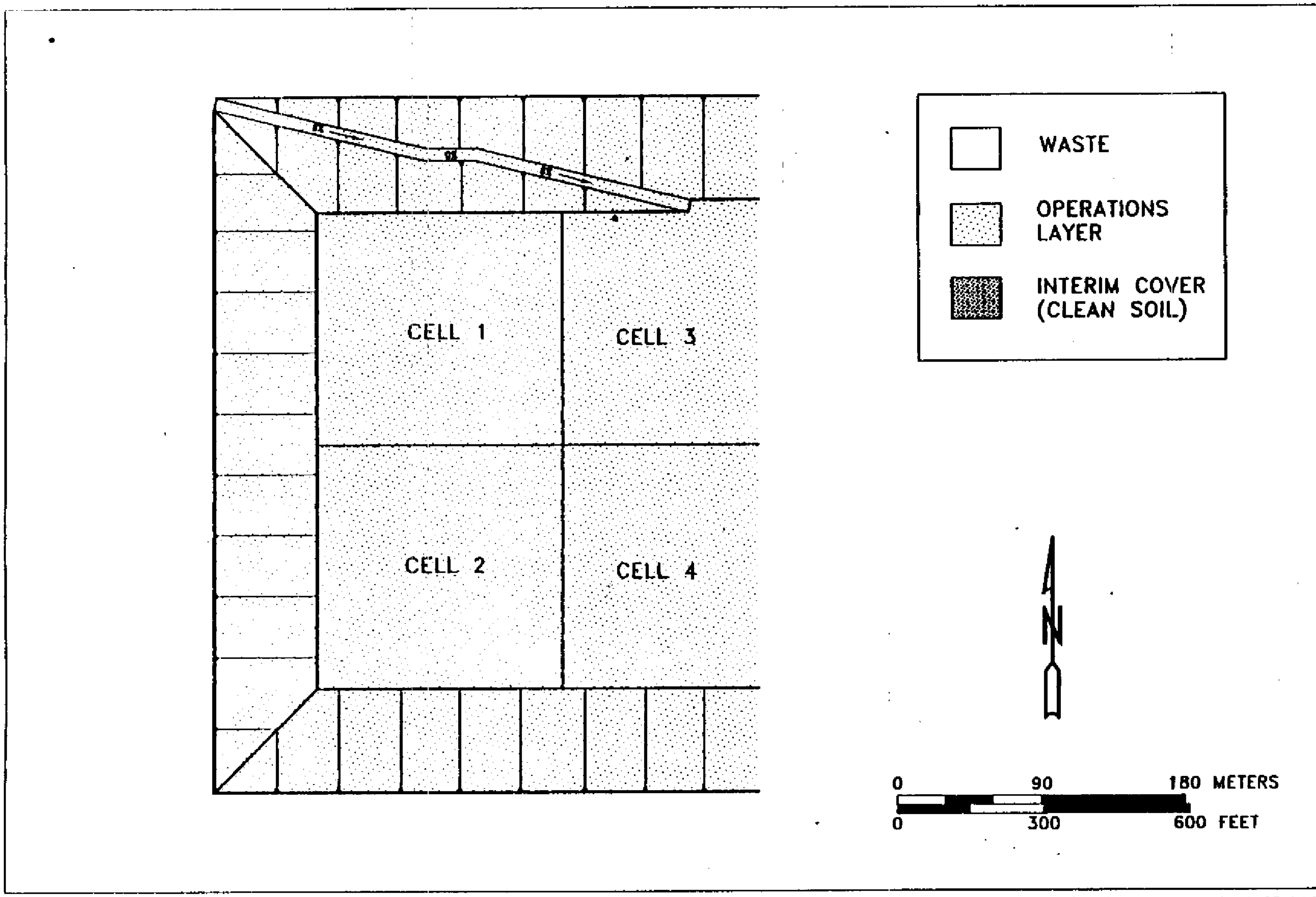
- Third, the filling sequence should permit timely placement of interim cover materials and enable waste hauling equipment to operate on "clean" surfaces, where possible.

- Fourth, continuous "clean" access should be available to each of the operating levels within the trench, with minimal disruption associated with extending and relocating access ramps as the trench is filled.

The area fill trench will be constructed in a series of cells with construction starting at the west end of the trench. The trench will be 70 ft deep with 3H:1V sideslopes; the trench bottom dimensions of each cell will be approximately 500 ft square. Waste will be placed in two lifts. The upper surfaces of these lifts will be located about half way up the trench and at the top of the trench, respectively. Access to the lower lift will be from a ramp constructed in the sideslope of the trench. Access to the upper lift will be directly from the roadway around the perimeter of the trench.

Vehicles hauling waste for disposal in the trench will generally operate on clean surfaces so that it will not be necessary to decontaminate the hauling equipment. Dedicated "dirty" operating equipment within the trench will be used to spread and stack the waste. Waste will be spread to maintain operating slopes no steeper than 3H:1V to meet stability requirements, although flatter operating slopes may be used for operational reasons. Dirty equipment will not generally be removed from the waste areas except for necessary maintenance, and so will require decontamination relatively infrequently.

As shown on Figure 3-1, access to the initial group of cells will be via a ramp constructed on the north slope of the trench. The ramp will be constructed at an eight percent grade with the exception of an horizontal segment approximately 100 ft long located 35 ft below the crest of the trench, at the mid height of the sideslope. This segment will allow access to the first lift of waste, as discussed in more detail below. Contaminated vehicles and equipment will not be driven or operated on the access ramp. A clean area will be delineated on the cell bottom at the bottom of the access ramp. This area will be



\CDR\SAIC\42752 11-1-93 14:37

Figure 3-1. Trench Filling Sequence, Prior to Waste Placement used for temporary storage of clean equipment and materials, and will define the limits within which clean equipment can operate at the bottom of the area fill trench.

The following approach for placing waste in the trench is based on concepts developed in the ERDF transportation study (COE 1993b). It is intended to minimize initial construction effort for the trench while still accommodating expected waste receipts. Variations of this approach are possible and can be developed if project requirements change.

3.1 INITIAL STACKING PLAN

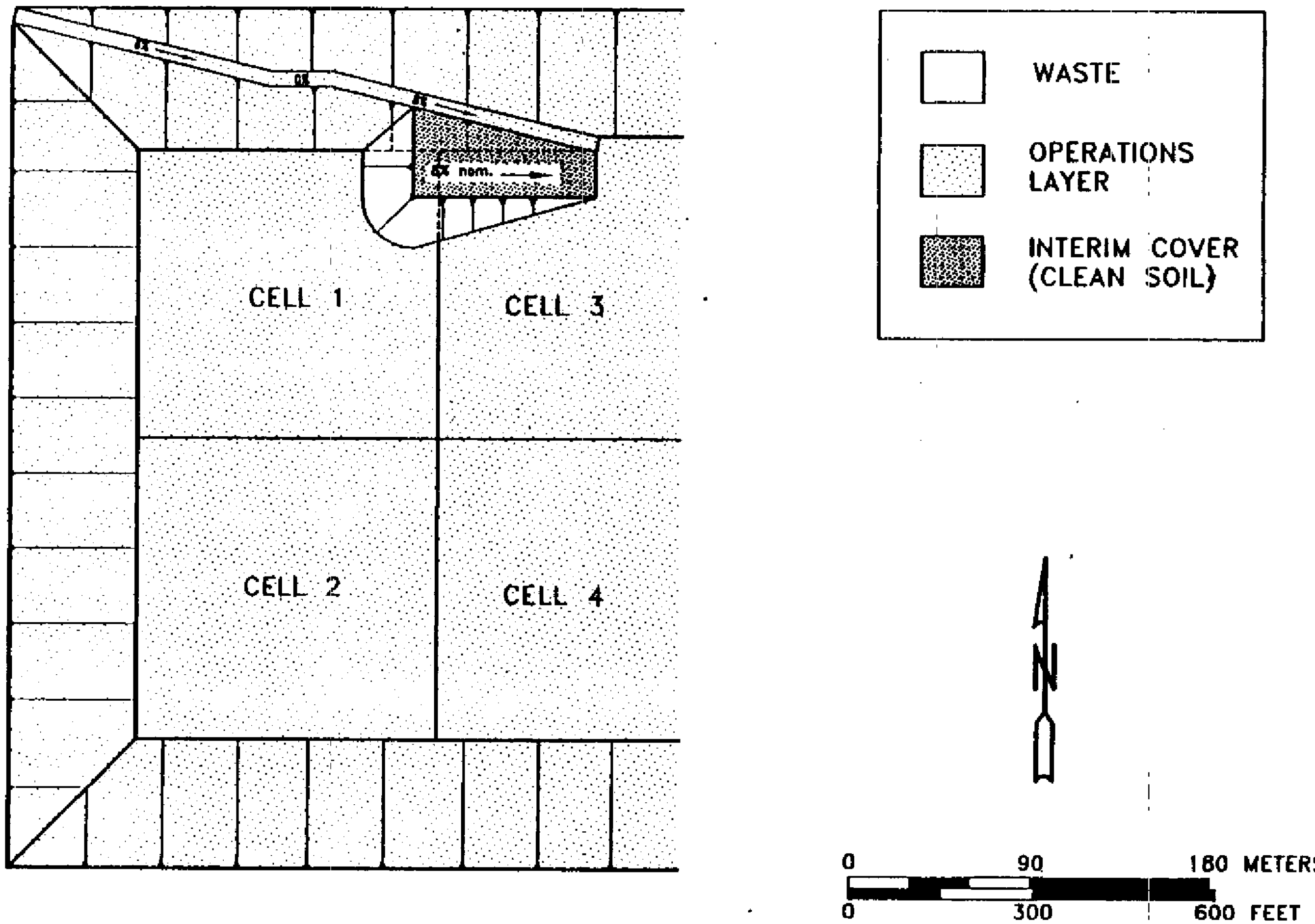
During initial placement of the waste, waste will be hauled down the access ramp to the clean operations layer on the bottom of the landfill cell. A waste ramp and dumping platform approximately 100 ft wide will be developed adjacent to the access ramp, upward from the operations layer at an eight percent grade. The ramp will initially be developed by dumping the waste directly on the operations layer. The waste will be spread, shaped, and compacted into the form of a ramp by dirty bulldozers. The waste ramp outslopes will be maintained at a grade of 3H:1V or flatter. The crest of the waste ramp will be oriented parallel the crest of the trench in plan view so the width of the waste ramp will increase with elevation. This will ensure that stability requirements for the placement of waste against the trench sideslopes are met.

When a sufficient area of waste ramp has been constructed, clean bulldozers and graders will be used to place a layer of clean soil on top of the waste. This stage of ramp construction is shown on Figure 3-2. The clean soil layer will serve as an interim cover to prevent wind dispersion of contaminated soil and to provide a clean surface for hauling equipment.

The point at which the waste trucks dump their loads will move progressively up slope as the area of clean cover is extended up the waste ramp. As the development of this ramp progresses, it will not be necessary for the waste trucks to travel all the way to the bottom of the cell. Since the dumping ramp will be simply a lateral extension of the access ramp, trucks will be able to pull off the access ramp onto the dumping ramp at any convenient location. This will minimize their travel and backup distances.

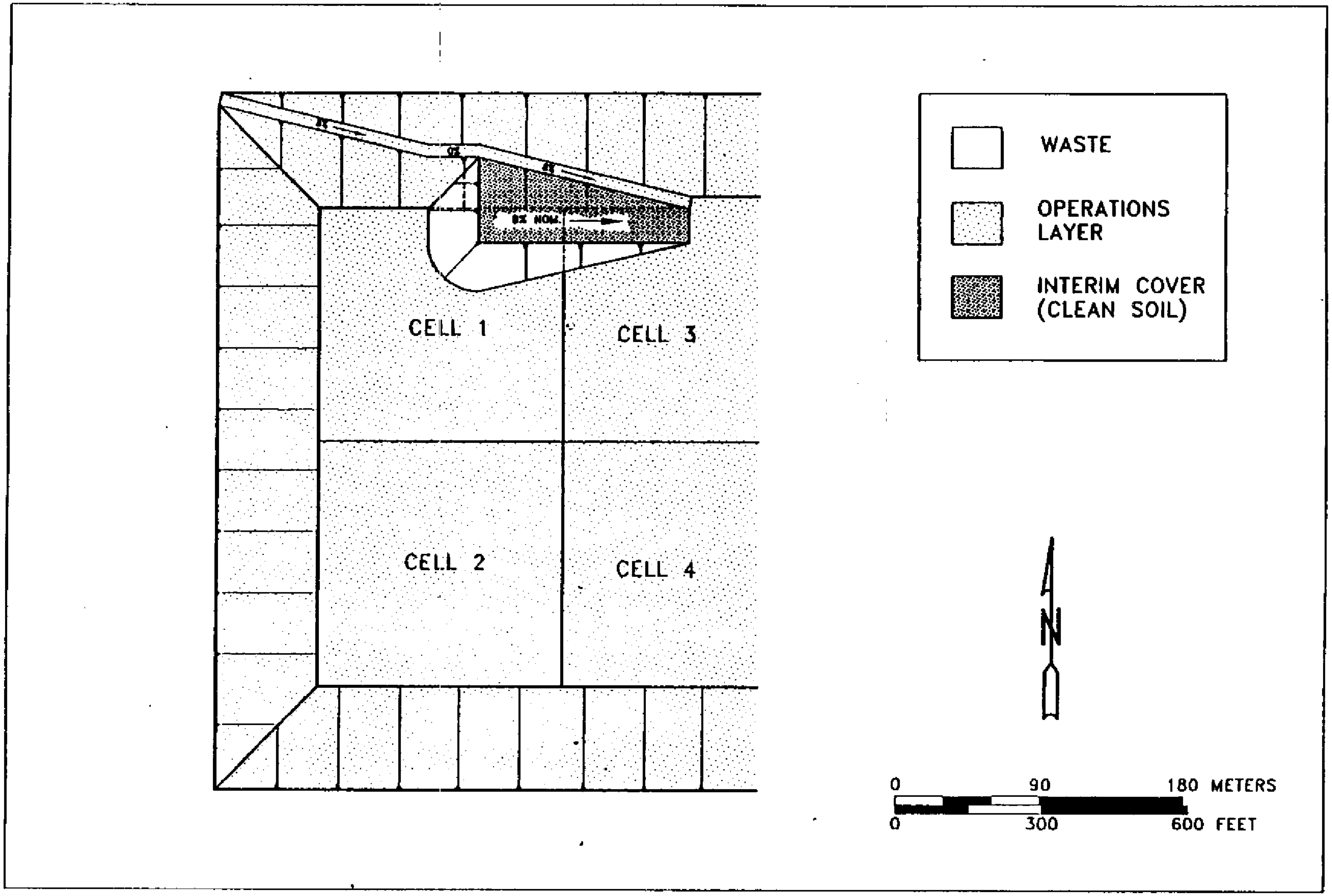
Development of the waste ramp will continue up slope using this method until the horizontal segment of the access ramp is reached, some 35 ft above the base of the trench (Figure 3-3). A 100-ft-wide horizontal section of the dumping platform corresponding to the horizontal ramp segment will be established at this elevation, as shown on Figure 3-4. This horizontal bench will be the initial stage in the development of a lower operating bench. The lower operating bench will be developed and maintained at this elevation throughout the operation of the area fill trench. The lower operating bench will initially be extended to the western limit of Cell 1 (Figure 3-5), and subsequently in a southerly direction to the southern limit of Cell 2 (Figure 3-6).

At some convenient time during development of the lower operating bench, an upper waste ramp will be constructed from the lower operating bench to the crest of the trench using a similar technique to that used for the lower waste ramp (Figure 3-7). The waste ramp will again be constructed as an extension of the access ramp. A minimum



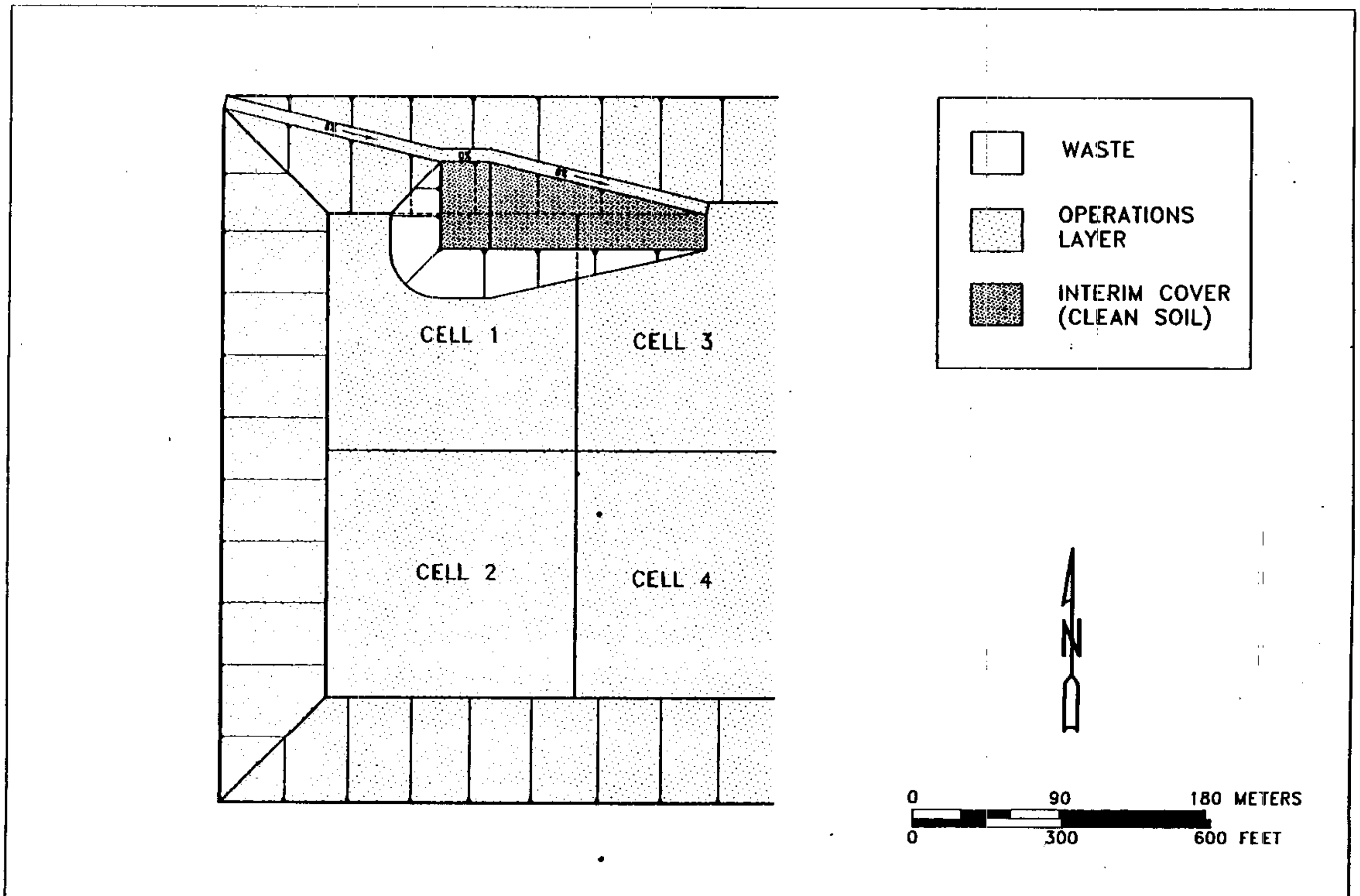
\CDR\42753 11-1-93 14:41

Figure 3-2. Trench Filling Sequence, Stage 1



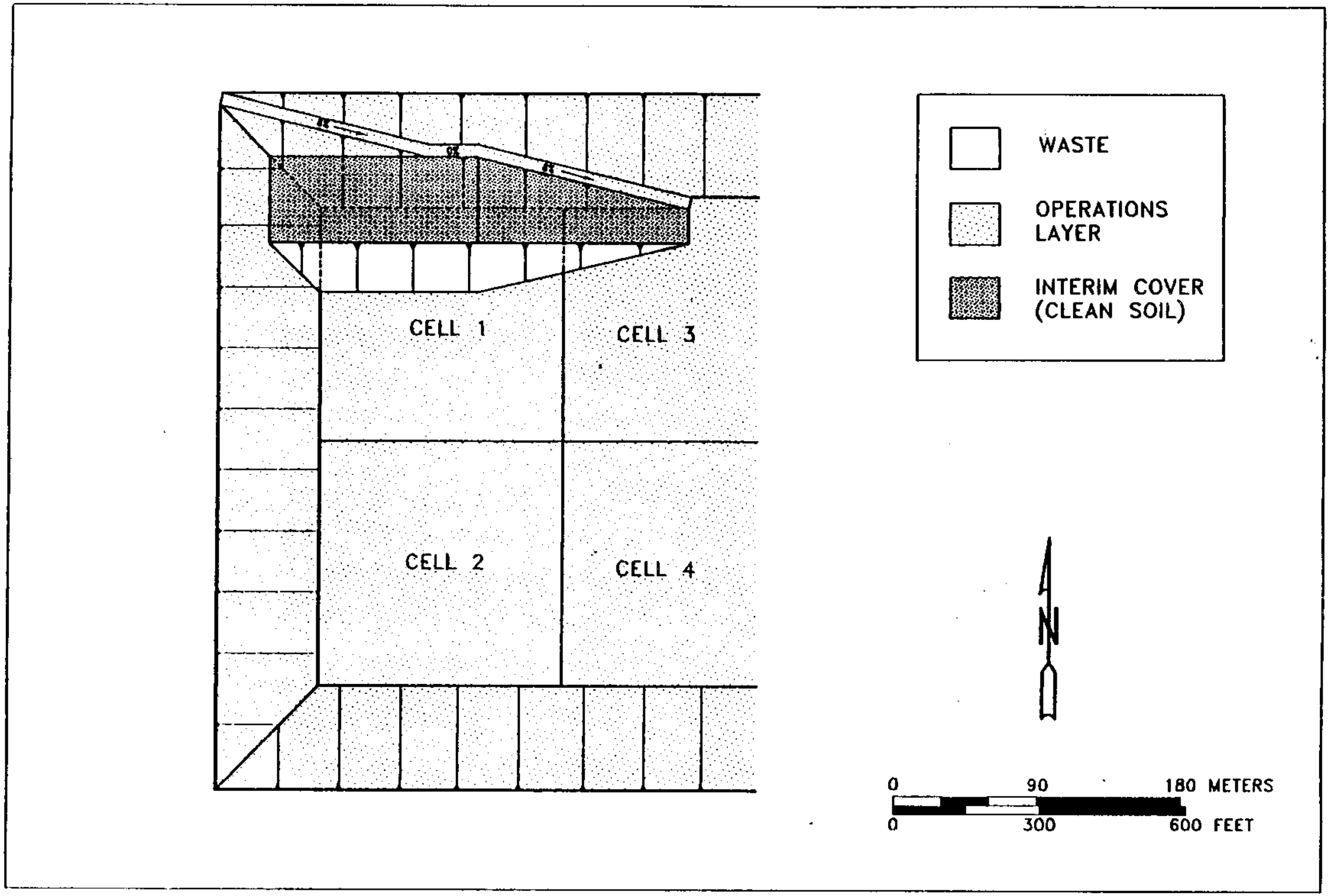
\CDR\SAIC\42754 11-4-93 8:59

Figure 3-3. Trench Filling Sequence, Stage 2



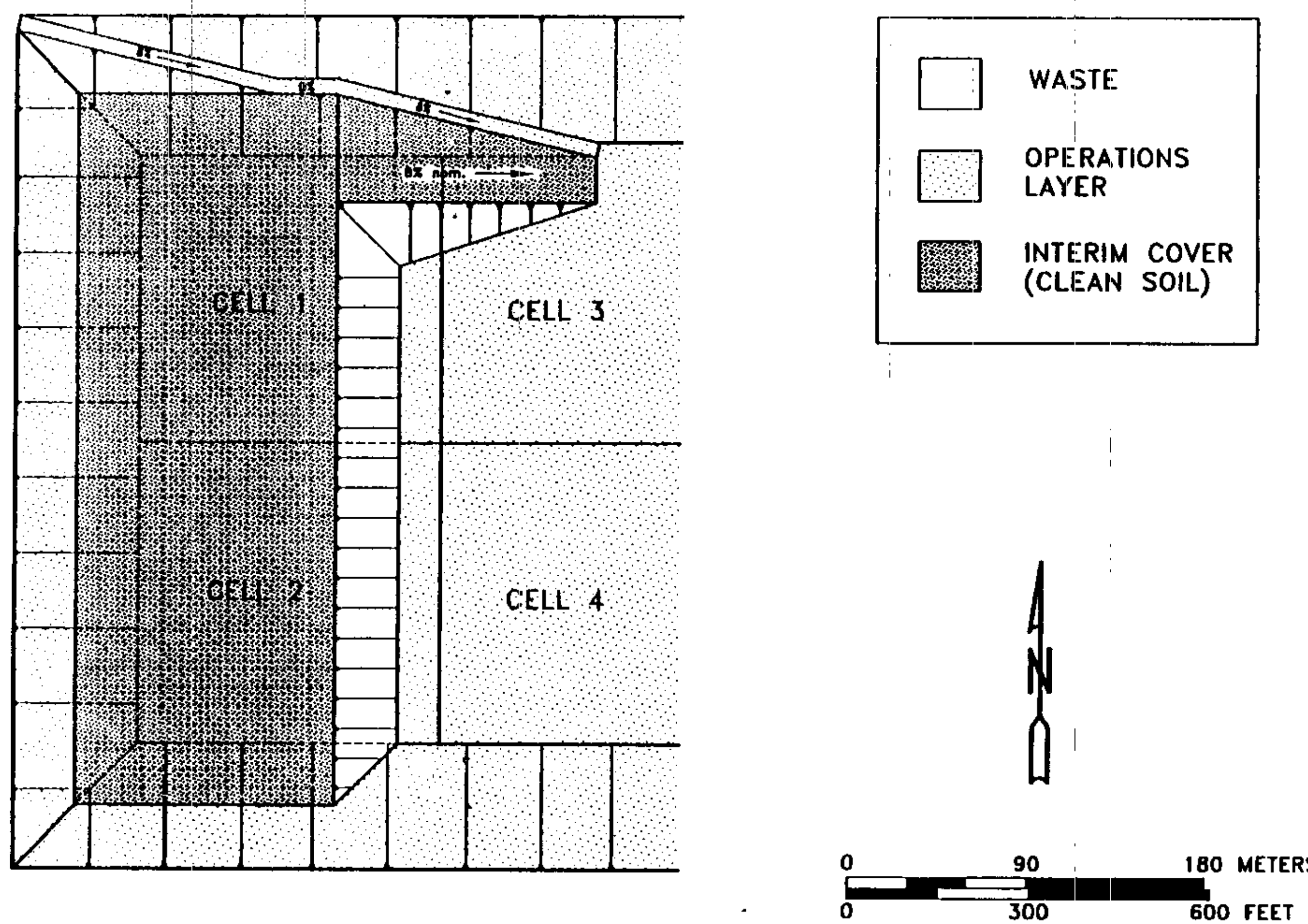
\CDR\SAIC\42755 11-4-93 8:10

Figure 3-4. Trench Filling Sequence, Stage 3



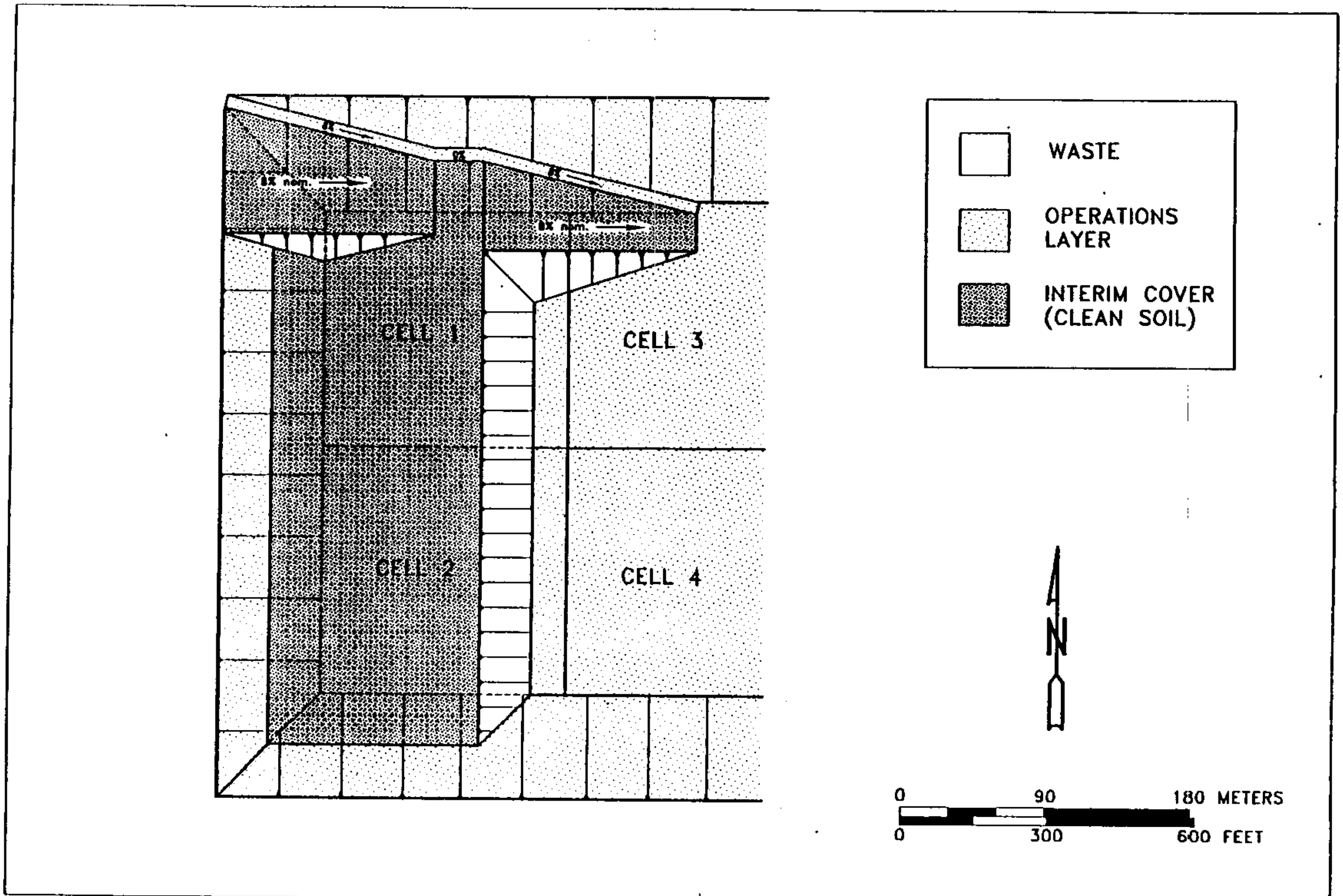
\CDR\SAIC\42756 11-4-93 8:14

Figure 3-5. Trench Filling Sequence, Stage 4



\CDR\SAIC\42757 11-4-93 8:17

Figure 3-6. Trench Filling Sequence, Stage 5



\CDR\SAIC\42758 11-4-93 8:21

Figure 3-7. Trench Filling Sequence, Stage 6

100-ft-wide access zone will be maintained on the lower operating bench at the toe of the upper waste ramp.

Following completion of the upper waste ramp, an upper operating bench will be developed over the upper waste ramp from the crest of the trench (Figure 3-8). This upper operating bench will then be extended to the south until it extends across the full width of Cells 1 and 2 (Figure 3-9). A minimum 100-ft-wide operating zone will be maintained on the lower operating bench, between the toe of the upper operating bench and the crest of the lower operating bench.

3.2 GENERAL STACKING PLAN

The basic system for filling the trench consists of the following general procedures:

- First, dumping the waste over the edge of a ramp or platform surfaced with clean material.
- Second, spreading the waste on an outslope using dirty equipment.
- Third, covering the waste with clean material as the ramp or dumping platform is extended.

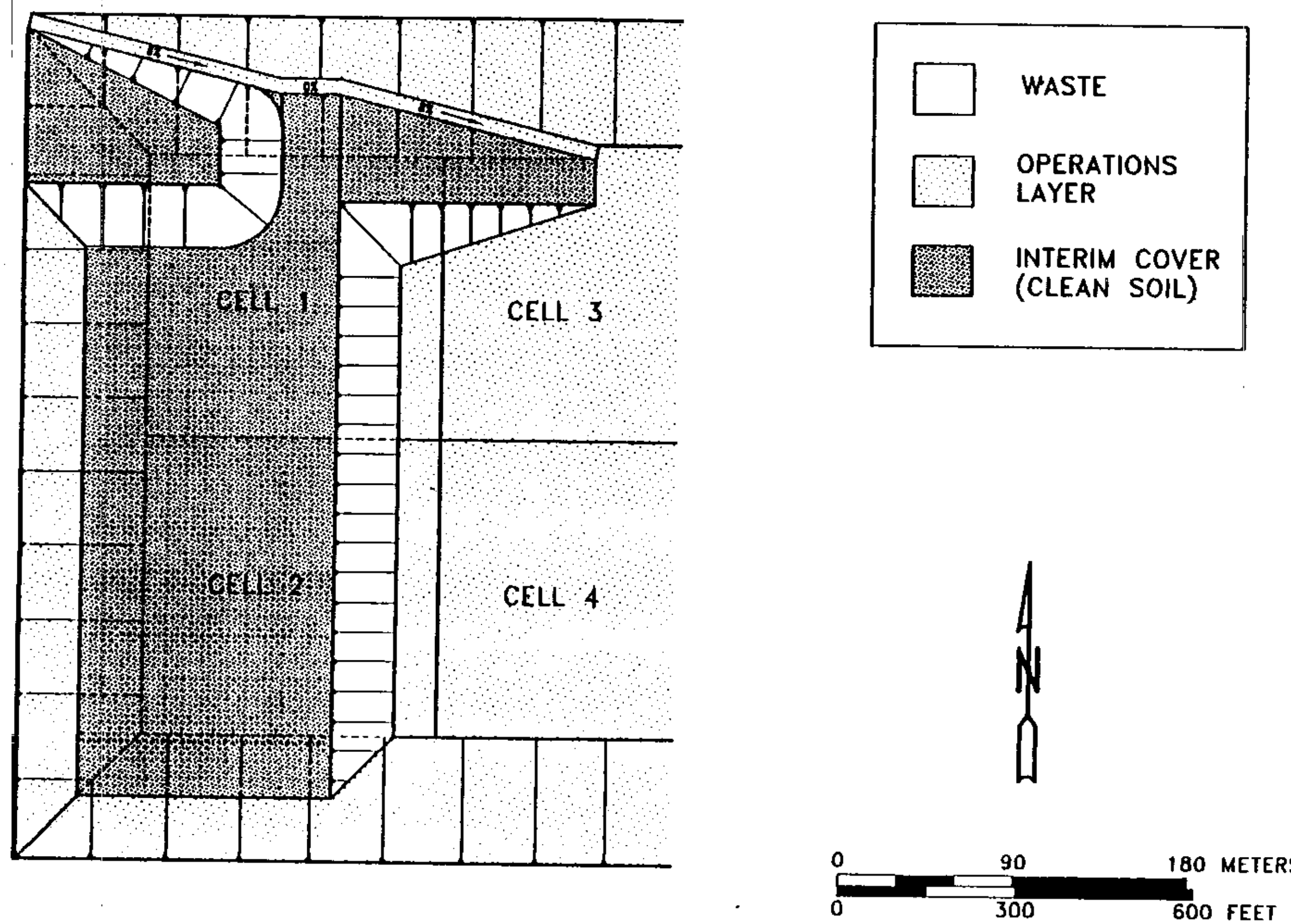
The general filling sequence of the trench will progress from west to east using the two operating benches developed as described above (Figure 3-10). A minimum width of 100 ft will be maintained on the lower bench to facilitate operations. The original access ramp will be maintained during filling of the first four cells. It will subsequently be replaced by a similar access ramp constructed adjacent to cells 5 and 7. The original access ramp will be infilled when the new ramp and adjacent cells become operational. This process will be repeated as necessary along the length of the trench.

The 3H:1V waste slopes will in general not be covered with an interim soil layer. The exposed area is minimal, and because the slopes will be advanced only a few tens of feet at a time, a clean soil cover would result in substantial lost landfill capacity. Dust from the exposed waste surfaces will be controlled with surfactants during normal operations. However, for areas which may remain open for long periods of time or experience disturbance from nearby traffic, such as the slopes adjacent to the access ramp, clean soil cover may be considered to reduce maintenance requirements.

3.3 OPERATIONS/CONSTRUCTION INTERFACE

Under this conceptual fill plan, cells 1 through 3 will be constructed and lined prior to waste placement. On average, about two new cells will need to be developed and lined each year to meet the planned disposal rates. Excavation and/or lining of new cells can be performed simultaneously with waste disposal.

Once the trench is in the operating phase, the waste placement and cell construction activities will be kept separate to avoid dispersion of contaminated material. Primary access for new cell construction will be provided by ramps within the unlined



\CDR\SAIC\42759 11-4-93 9:38

Figure 3-8. Trench Filling Sequence, Stage 7

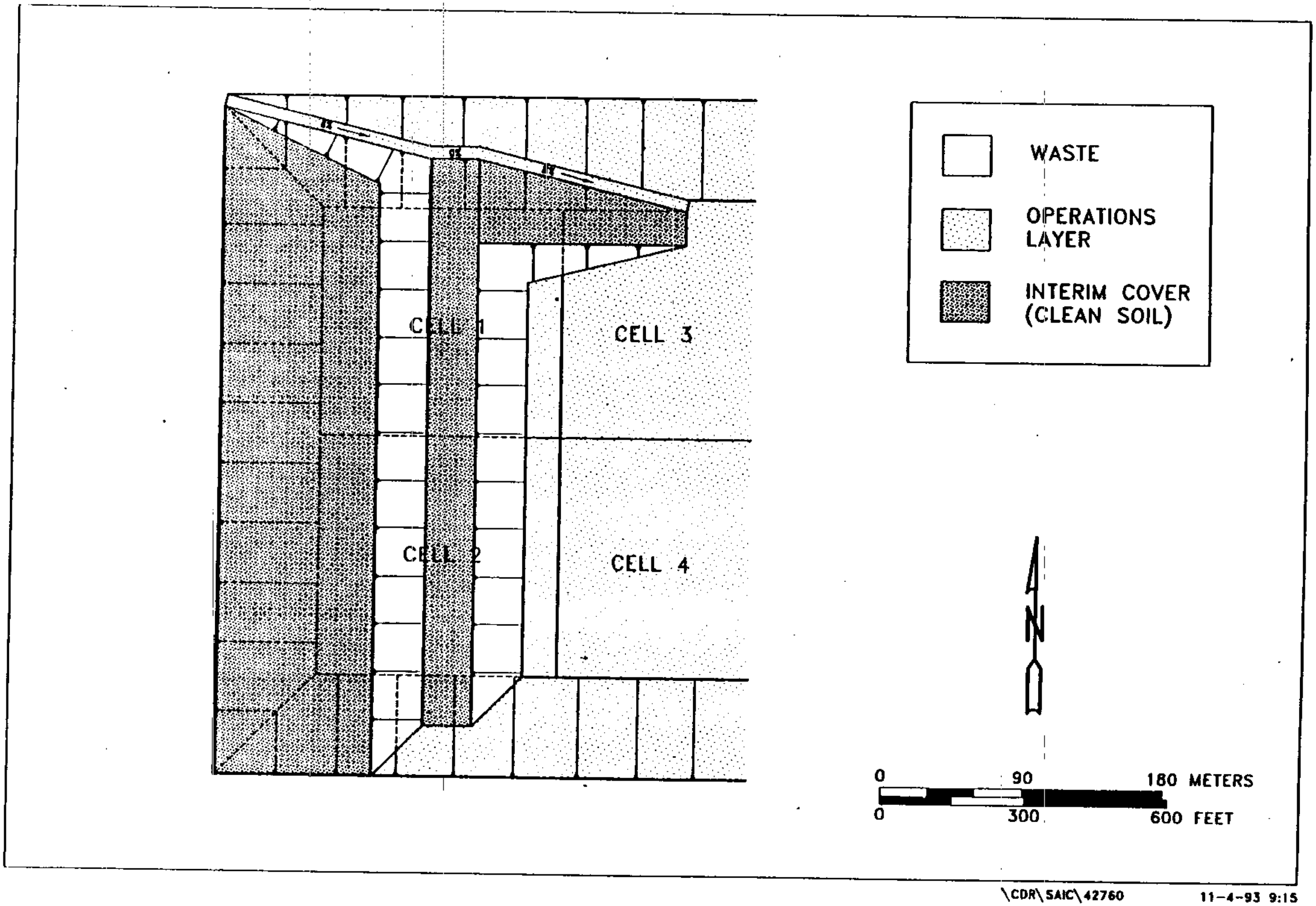


Figure 3-9. Trench Filling Sequence, Stage 8

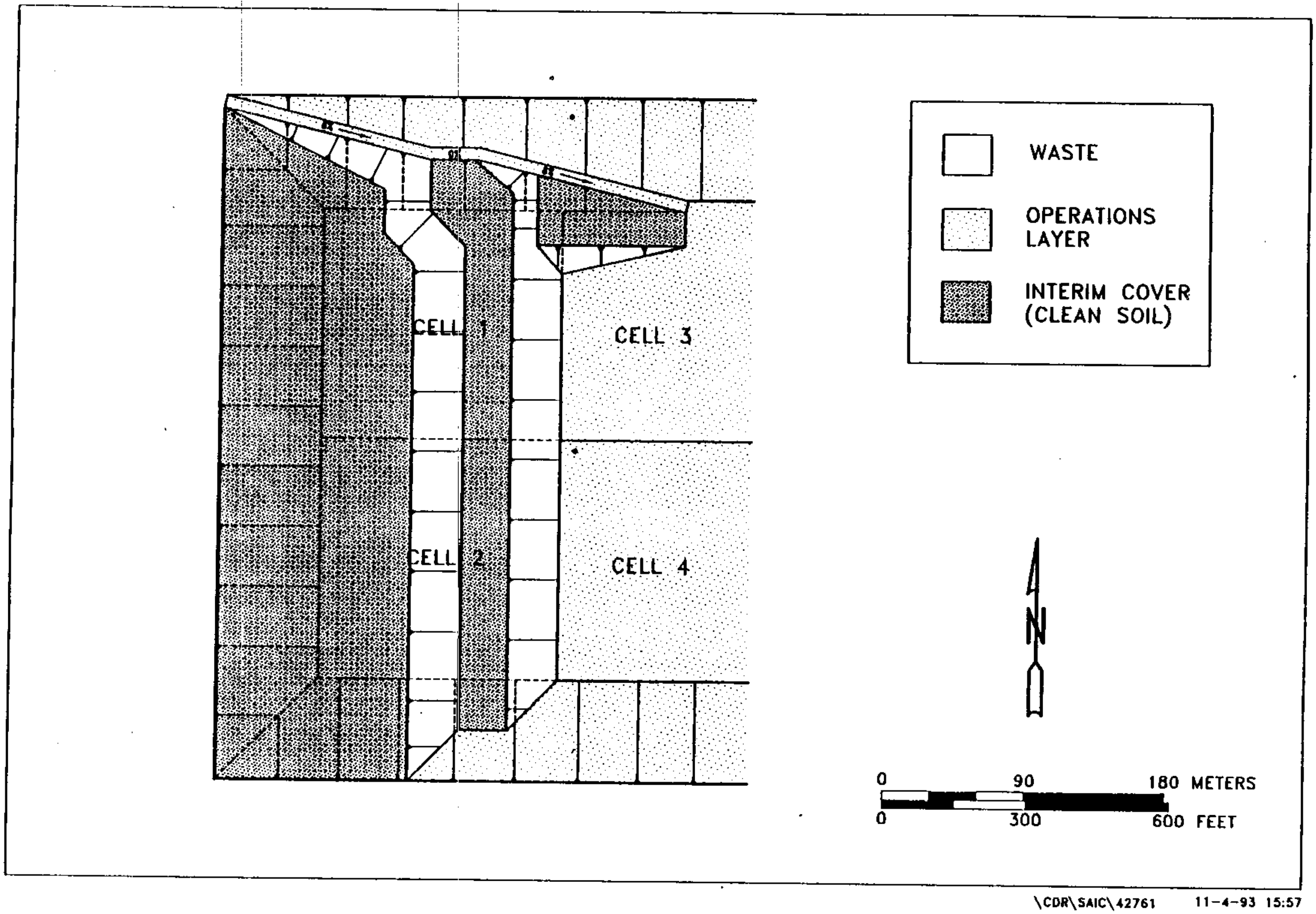


Figure 3-10. Trench Filling Sequence, Stage 9

slopes of the new construction area, at the eastern end of the existing trench. Construction stockpiles, equipment yards, and support facilities will be limited to the area south and east of the trench. The north and west sides will be dedicated to waste transport and placement operations. Within the trench, the construction area will be separated from the waste placement area by a buffer (no activity) zone and a physical barrier such as a fence.

3.4 MINIMAL STARTUP REQUIREMENTS

Prior to initiating waste disposal, it will be necessary to develop a sufficient area of lined cells to allow continuous disposal activities. At a minimum, it will be necessary to excavate and line at least three cells. Cells 1 and 2 will provide the primary initial disposal capacity. Cell 3 will provide access to the bottom of the trench, in addition to providing a buffer between waste disposal and construction activities. This configuration would provide a maximum capacity of approximately eighteen months of disposal at the planned waste generation rates before Cell 4 would need to be completed (see below).

3.5 FIVE-YEAR OPERATING PLAN

The total volume of waste scheduled for disposal in the area fill trench during the first five years of operation is approximately six million cubic yards, with the estimated annual disposal rate as follows (WHC 1993):

Year	Waste Volume (cubic yards)	
	Annual	Cumulative
1	653,000	653,000
2	1,413,000	2,066,000
3	1,215,000	3,281,000
4	1,321,000	4,602,000
5	1,407,000	6,009,000

The cumulative landfill capacity depends in part on the sequence in which the cells are constructed and filled. For comparison purposes, the cumulative capacity of the first six cells is presented in the table below. This estimate assumes that the constraints on waste geometry discussed above will apply. This estimate also assumes that the first access ramp will be kept open until Cell 7 has been lined, at which time the second ramp will be used and the first can be backfilled with waste. This approach limits the volume of waste that can be placed along the north side of the trench. Details of the volume calculation are presented in Appendix B.

Available Cells	Cumulative Waste Capacity (cubic yards)
1 and 2	1,080,000
1, 2, and 3	1,260,000
1 through 4	2,370,000
1 through 6	3,460,000

Since disposal is proposed from west to east across the full two-cell width of the trench, it is assumed that new cells will generally be constructed and lined in pairs (i.e., 5 and 6, 7 and 8) ahead of the operating cells. The capacity of each two disposal cells is approximately 1.5 million cubic yards. This corresponds to about one year of waste receipt at the planned disposal rate, with the exception of the reduced disposal rate planned for the first year. At the end of five years, it is estimated that approximately eight to ten cells will have been constructed and filled.

4.0 INTERIM COVER REQUIREMENTS

No regulatory requirements for a low-permeability interim cover have been identified (COE 1993a). However, it may be economical to install such a cover to limit the amount of leachate that must be treated prior to installation of the permanent closure cover (the Hanford Barrier; COE 1993a). This section will estimate the amount of leachate that may be generated and the costs of treatment vs. installation of a low-permeability interim cover.

4.1 LEACHATE GENERATION RATES

The amount of leachate that might be generated was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) computer model (Schroeder et al. 1989). Details of the analysis are included in Appendix C. Climatic data for the Hanford Site from the years 1979 through 1988 were used. The waste was assumed to be 70 ft thick and consist of sandy gravel. The interim cover was assumed to be a 2-ft-thick layer of silty sand. All materials were assumed to be at their field capacity initially, and thus have no storage capacity. This is a conservative assumption which will maximize the infiltration through the waste.

Leachate production was calculated for several assumed permeability values of the interim cover soil. Results ranged from 0.7 in. of leachate per year for a cover permeability of 1×10^{-5} cm/sec to 1.1 in. per year for a permeability of 1×10^{-3} cm/sec. These values are equivalent to 19,000 and 30,000 g/ac, respectively. For comparison purposes, leachate production at a landfill at the Arlington, Oregon, hazardous waste facility ranges from about 3,000 to 5,000 g/ac/yr (Appendix C). This landfill is double lined and is comparable in depth to the ERDF. The Arlington site receives more annual precipitation than Hanford, with 11 in. vs. 7 in. for the years considered. On this basis, it appears that the HELP results for the ERDF are in fact conservative.

4.2 LEACHATE TREATMENT COSTS

Costs for leachate treatment will depend on the volume to be treated and the constituents that must be removed. Hence, costs are difficult to determine accurately at this time. Estimates provided by WHC for a proposed waste water treatment facility (Appendix C) indicate costs of about $0.06 per gallon. Rule-of-thumb estimates for wastewater treatment plants indicate about $0.01 per gallon, even assuming a small plant and use of reverse osmosis to remove dissolved metals. Commercial hazardous waste facilities were queried about leachate treatment costs, but did not have this information available.

4.3 LOW-PERMEABILITY COVER COSTS

Two options were considered for low-permeability covers. The first is a 3-in.-thick layer of asphalt, costed at $1.50 per square foot installed. The second is a 20-mil layer of very low density polyethylene (VLDPE), costed at $0.50 per square foot installed. VLDPE was selected for its durability and toughness. Both covers assume no traffic and consequently do not include layers that would normally be necessary to accommodate vehicle loads. Details of the cost derivation are included in Appendix D.

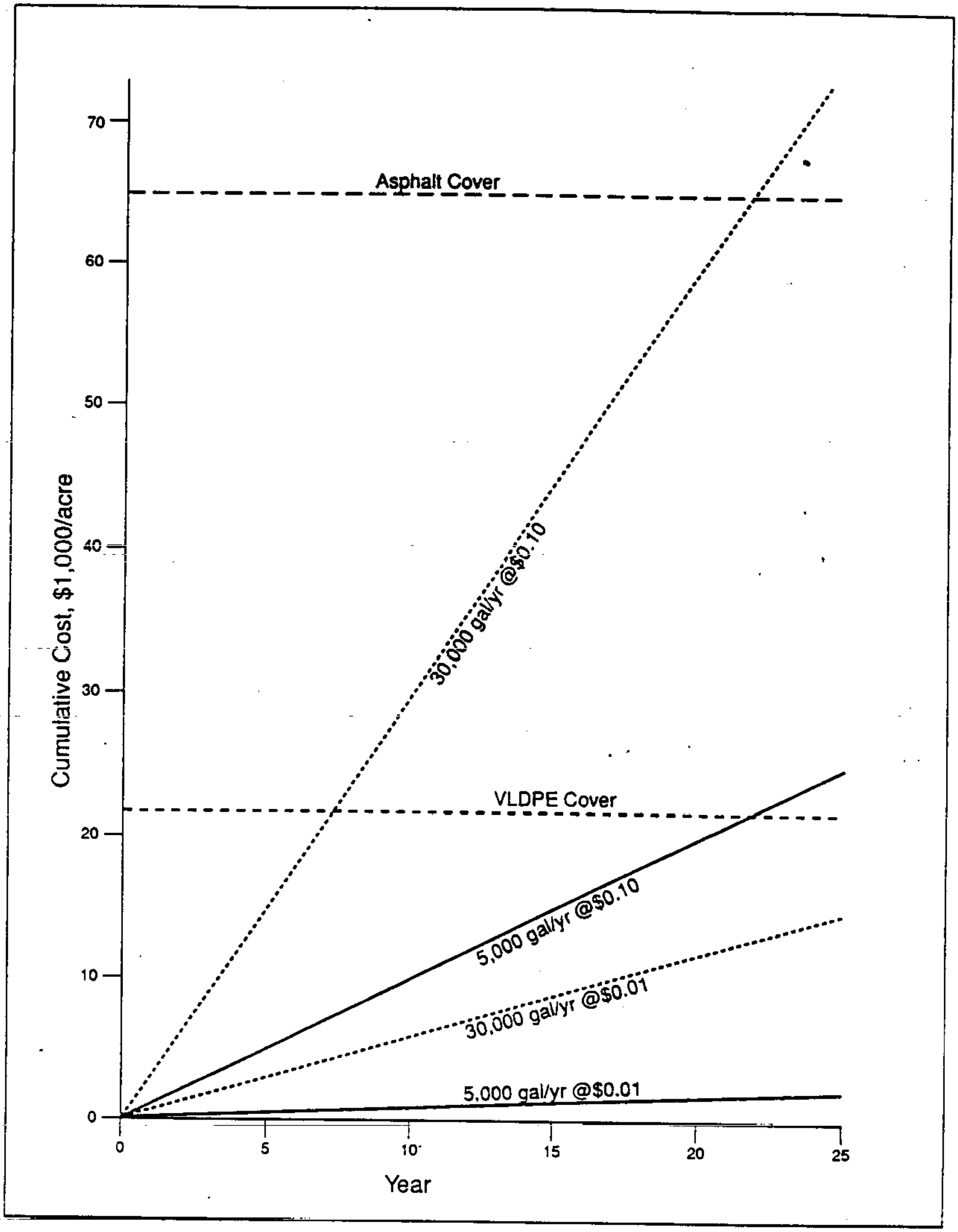
4.4 RESULTS

The results are shown on Figure 4-1, where costs on a per-acre basis for leachate treatment and low-permeability cover construction have been plotted for a period of 25 years. This time period reflects the expected life of the ERDF (years 1996 to 2018) plus a few years for construction of the Hanford Barrier.

Because of its higher cost, the asphalt cover is not economical compared to the VLDPE cover. At this time, no performance requirements have been identified that would require the use of asphalt instead of geomembrane.

The cost curves on Figure 4-1 indicate that the VLDPE cover is not justified economically unless both leachate quantities and treatment costs are at the high end of the expected range, and the area under consideration is not permanently closed for several years. For example, if leachate is being generated at a rate of 30,000 g/yr and if treatment costs $0.10/g, then a VLDPE cover is justified only if about 7 years or more elapse before the Hanford Barrier is installed at that location. A low-permeability cover also has significant initial costs, whereas leachate treatment can be incorporated into the wastewater treatment facility already required for the ERDF.

As discussed above, there is considerable uncertainty in both the volume and cost of treating leachate. However, there is no significant cost impact for installing a low-permeability cover after a few years rather than immediately when a particular section of the trench is full. Hence, actual leachate quantities should be monitored during ERDF operation and actual costs determined. On this basis, a decision can be made at any time to install a low-permeability cover if justified.



923 E046.200/47333/11-29-93

Figure 4-1. Interim Cover Costs.

5.0 SUMMARY AND CONCLUSIONS

Stability analyses were performed to evaluate liner stability and to determine constraints on waste placement operations. The analyses considered both static and dynamic loading conditions. The following results were obtained:

- Sideslopes of 3H:1V can be excavated in the subgrade.
- The proposed liner with operations layer can be constructed on these 3H:1V sideslopes.
- Overall operational slopes within the waste should be limited to 3H:1V. Where these slopes are located above the trench sideslopes, somewhat flatter waste slope angles might be required depending on the results of strength testing on actual liner materials.
- Where waste is located above the trench sideslopes, it should at all times during the operation be buttressed by at least an equivalent quantity of waste located above the flat base of the trench.

On the basis of these constraints, the trench geometry, and the need to minimize initial trench construction, a conceptual fill plan was prepared. Waste placement would begin on the floor of the trench, and operating levels at elevations of 35 and 70 ft above the trench floor would be developed. The amount of waste exposed at any given time would be minimized by the use of clean soil covers. Initial construction of 3 cells would provide capacity for about 1.5 years of waste at currently anticipated receipt rates. Additional cells would be excavated and lined at a rate of about 2 per year. This process would advance the trench by about 500 ft annually. Within broad limits, these construction rates can be modified to accommodate actual waste receipts. Construction activities will be isolated from waste placement activities to prevent inadvertent spread of contaminated material.

The need for a low-permeability interim cover over portions of the trench that have been completely filled was also evaluated. The economics of treating leachate depend on the amount of leachate generated and the unit cost of treatment. Neither of these factors is well-defined for the ERDF. However, using estimates based on modelling and experience at other facilities, it appears that a low-permeability interim cover is not economical unless both leachate volumes and unit treatment costs are relatively high. It is suggested that a final decision on the need for a low-permeability interim cover be deferred until actual operating experience at the ERDF has more accurately defined the relevant parameters.

6.0 REFERENCES

COE, 1993a, Engineering Study for the Trench and Engineered Barrier Configuration for the Environmental Restoration Storage and Disposal Facility, DOE/RL/12074--13 Rev. 0, U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

COE, 1993b, On-Site Transportation Network Engineering Study for the Environmental Restoration Storage and Disposal Facility, DOE/RL/12074--12 Rev. 0, U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

DOE, 1989, "Design Loads for Facilities", in Hanford Plant Standards - Architectural-Civil Design Criteria, SDC-4.1, Revision 11, U.S. Department of Energy, Richland, Washington.

Golder Associates Inc., 1989, Site Investigation Report, Non-Drag-Off Landfill Site, Low-Level Burial Area No. 5, 200 West Area, U.S. Department of Energy, Richland, Washington.

Golder Associates Inc., 1992, Design Report, Project W-025 Radioactive Mixed Waste (RMW) Land Disposal Facility, Non-Drag-Off, WHC-SD-W025-FDR-001 Rev. 1, U.S. Department of Energy, Richland, Washington.

Golder Associates Inc., 1993, Material Specifications and Construction Requirements for the Radioactive Mixed Waste Land Disposal Facility, Non-Drag-Off, WHC-S-045 Rev. 2, U.S. Department of Energy, Richland, Washington.

Schroeder, P.R., R.L. Peyton, B.M. McEnroe, and J.W. Sjostrum, 1989, The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 2.05, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Sharma, S., 1991, XSTABL, An Integrated Slope Stability Analysis Program for Personal Computers, Ver. 4.10, Interactive Software Designs, Moscow, Idaho.

WHC, 1993, Functional Design Criteria, Environmental Restoration Storage and Disposal Facility, Project W-296, WHC-SD-W296-FDC-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

STABILITY CALCULATIONS

XSTABL File: TOS1SCH 11-04-93 15:12

Analysis A1

```
******************************************
*                 XSTABL                 *
*                                        *
*     Slope Stability Analysis using     *
*   Simplified BISHOP or JANBU methods   *
*                                        *
*          Copyright (C) 1992            *
*   Interactive Software Designs, Inc.   *
*          All Rights Reserved           *
*                                        *
*                                        *
*        Golder Associates, Inc.         *
*          Redmond,  WA 98052            *
*                                        *
*  Ver. 4.10                      1015   *
******************************************
```

Problem Description : Hanford W-296 Trench Operations Seq

SEGMENT BOUNDARY COORDINATES

2 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	100.0	1
2	300.0	100.0	350.0	100.0	1

1 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	1.0	2

ISOTROPIC Soil Parameters

2 type(s) of soil

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	120.0	120.0	.0	30.00	.000	.0	0
2	120.0	120.0	.0	20.00	.000	.0	0

A critical failure surface searching method, using a random technique for generating sliding BLOCK surfaces, has been specified.

100 trial surfaces will be generated and analyzed.

3 boxes specified for generation of central block base

Length of line segments for active and passive portions of sliding block is 300.0 ft

Box no.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Width (ft)
1	.0	.0	.0	.0	.0
2	50.0	.0	250.0	.0	.0
3	300.0	100.0	300.0	100.0	.0

Factors of safety have been calculated by the :

* * * * * MODIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	153.23	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.037)

Failure surface No. 2 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	154.51	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.038)

Failure surface No. 3 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	157.62	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.038)

Failure surface No. 4 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	144.15	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.036)

Failure surface No. 5 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	159.00	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.038)

Failure surface No. 6 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	143.25	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.602 ** (Fo factor =1.036)

Failure surface No. 7 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	160.54	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.602 ** (Fo factor =1.039)

Failure surface No. 8 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	162.22	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.602 ** (Fo factor =1.039)

Failure surface No. 9 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	138.38	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.603 ** (Fo factor =1.035)

Failure surface No.10 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	165.93	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.603 ** (Fo factor =1.039)

The following is a summary of the TEN most critical surfaces

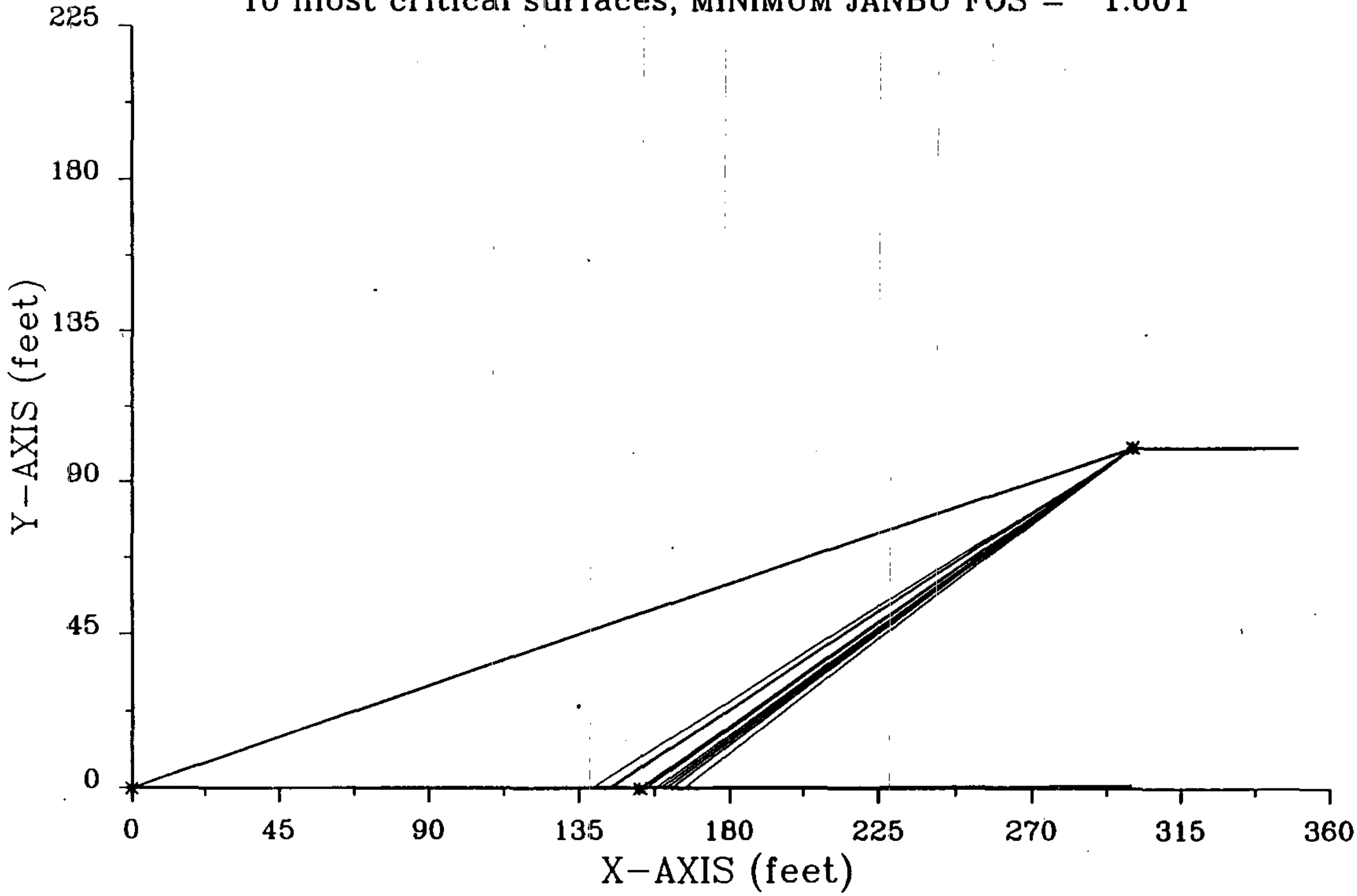
Problem Description : Hanford W-296 Trench Operations Seq

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Driving Force (lb)
1.	1.601	1.037	.00	300.00	2.725E+05
2.	1.601	1.038	.00	300.00	2.745E+05
3.	1.601	1.038	.00	300.00	2.793E+05
4.	1.601	1.036	.00	300.00	2.581E+05
5.	1.601	1.038	.00	300.00	2.814E+05
6.	1.602	1.036	.00	300.00	2.567E+05
7.	1.602	1.039	.00	300.00	2.837E+05
8.	1.602	1.039	.00	300.00	2.862E+05
9.	1.603	1.035	.00	300.00	2.488E+05
10.	1.603	1.039	.00	300.00	2.918E+05

* * * END OF FILE * * *

Hanford W-296 Trench Operations Seq

10 most critical surfaces, MINIMUM JANBU FOS = 1.601



Sheet 5 of 20

```
****************************************
*               XSTABL                 *
*                                      *
*    Slope Stability Analysis using    *
*  Simplified BISHOP or JANBU methods  *
*                                      *
*          Copyright (C) 1992          *
*   Interactive Software Designs, Inc. *
*          All Rights Reserved         *
*                                      *
*                                      *
*       Golder Associates, Inc.        *
*         Redmond,  WA 98052           *
*                                      *
*  Ver. 4.10                     1015  *
****************************************
```

Problem Description : Hanford W-296 Trench Operations Seq

SEGMENT BOUNDARY COORDINATES

2 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	100.0	1
2	300.0	100.0	350.0	100.0	1

1 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	1.0	2

ISOTROPIC Soil Parameters

2 type(s) of soil

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	120.0	120.0	.0	30.00	.000	.0	0
2	120.0	120.0	.0	20.00	.000	.0	0

A horizontal earthquake loading coefficient
of .120 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A critical failure surface searching method, using a random technique for generating sliding BLOCK surfaces, has been specified.

100 trial surfaces will be generated and analyzed.

3 boxes specified for generation of central block base

Length of line segments for active and passive portions of sliding block is 300.0 ft

Box no.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Width (ft)
1	.0	.0	.0	.0	.0
2	50.0	.0	250.0	.0	.0
3	300.0	100.0	300.0	100.0	.0

Factors of safety have been calculated by the :

* * * * * MODIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	157.62	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.038)

Failure surface No. 2 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00

Sheet 8 of 20

2	159.00	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.038)

Failure surface No. 3 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	160.54	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.039)

Failure surface No. 4 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	154.51	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.038)

Failure surface No. 5 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	153.23	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.037)

Failure surface No. 6 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	162.22	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.116 ** (Fo factor =1.039)

Failure surface No. 7 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00

2	165.93	.00
3	300.00	100.00

Sheet 9 of 20

** Corrected JANBU FOS = 1.117 ** (Fo factor =1.039)

Failure surface No. 8 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	169.52	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.117 ** (Fo factor =1.040)

Failure surface No. 9 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	144.15	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.118 ** (Fo factor =1.036)

Failure surface No.10 specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	143.25	.00
3	300.00	100.00

** Corrected JANBU FOS = 1.118 ** (Fo factor =1.036)

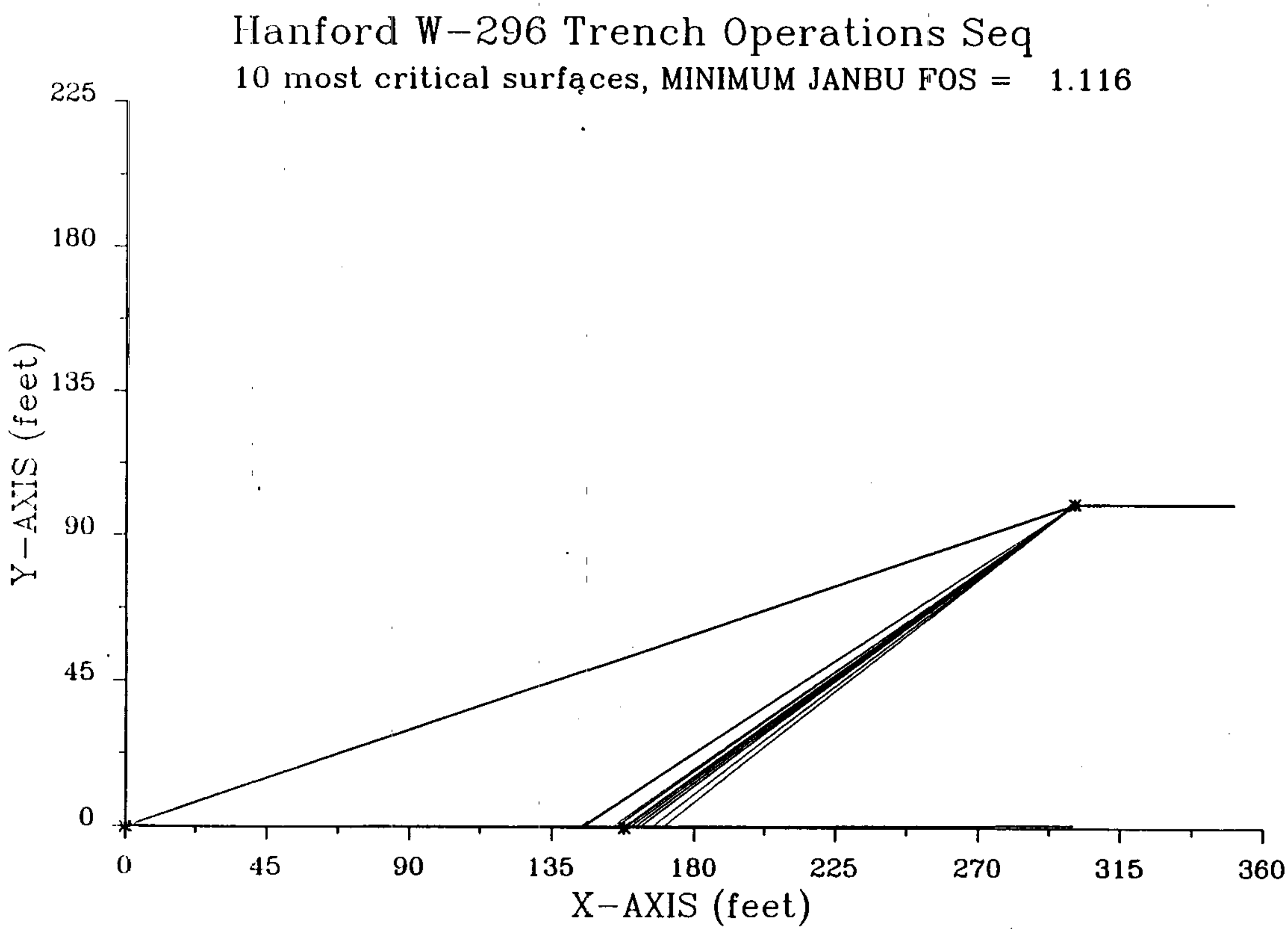
The following is a summary of the TEN most critical surfaces

Problem Description : Hanford W-296 Trench Operations Seq

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Driving Force (lb)
1.	1.116	1.038	.00	300.00	3.814E+05
2.	1.116	1.038	.00	300.00	3.844E+05
3.	1.116	1.039	.00	300.00	3.876E+05
4.	1.116	1.038	.00	300.00	3.748E+05
5.	1.116	1.037	.00	300.00	3.720E+05
6.	1.116	1.039	.00	300.00	3.911E+05
7.	1.117	1.039	.00	300.00	3.989E+05

8.	1.117	1.040	.00	300.00	4.061E+05
9.	1.118	1.036	.00	300.00	3.522E+05
10.	1.118	1.036	.00	300.00	3.502E+05

* * * END OF FILE * * *


Hanford W-296 Trench Operations Seq
10 most critical surfaces, MINIMUM JANBU FOS = 1.116
Y-AXIS (feet)
225
180
135
90
45
0
X-AXIS (feet)
0
45
90
135
180
225
270
315
360

Sheet 12 of 20

XSTABL File: TOS2   10-01-93   11:09

Analysis A2

```
*******************************************
*                 XSTABL                  *
*                                         *
*    Slope Stability Analysis using       *
*   Simplified BISHOP or JANBU methods    *
*                                         *
*           Copyright (C) 1992            *
*   Interactive Software Designs, Inc.    *
*           All Rights Reserved           *
*                                         *
*                                         *
*         Golder Associates, Inc.         *
*           Redmond,  WA 98052            *
*                                         *
*  Ver. 4.10                        1015  *
*******************************************
```

Problem Description :

SEGMENT BOUNDARY COORDINATES

2 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	100.0	1
2	300.0	100.0	350.0	100.0	1

1 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	300.0	1.0	2

ISOTROPIC Soil Parameters

2 type(s) of soil

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	120.0	120.0	.0	30.00	.000	.0	0
2	120.0	120.0	.0	20.00	.000	.0	0

A horizontal earthquake loading coefficient

A vertical earthquake loading coefficient
of .000 has been assigned

Sheet 13 of 20

Trial failure surface specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	.00	.00
2	150.00	.00
3	300.00	100.00

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION :
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	75.00	.00	25.000	150.000	.000	18.435	450000.0
2	150.38	.25	49.874	.754	33.690	18.435	4511.2
3	225.38	50.25	24.874	149.246	33.690	18.435	445488.7

SLICE INFORMATION ... continued :

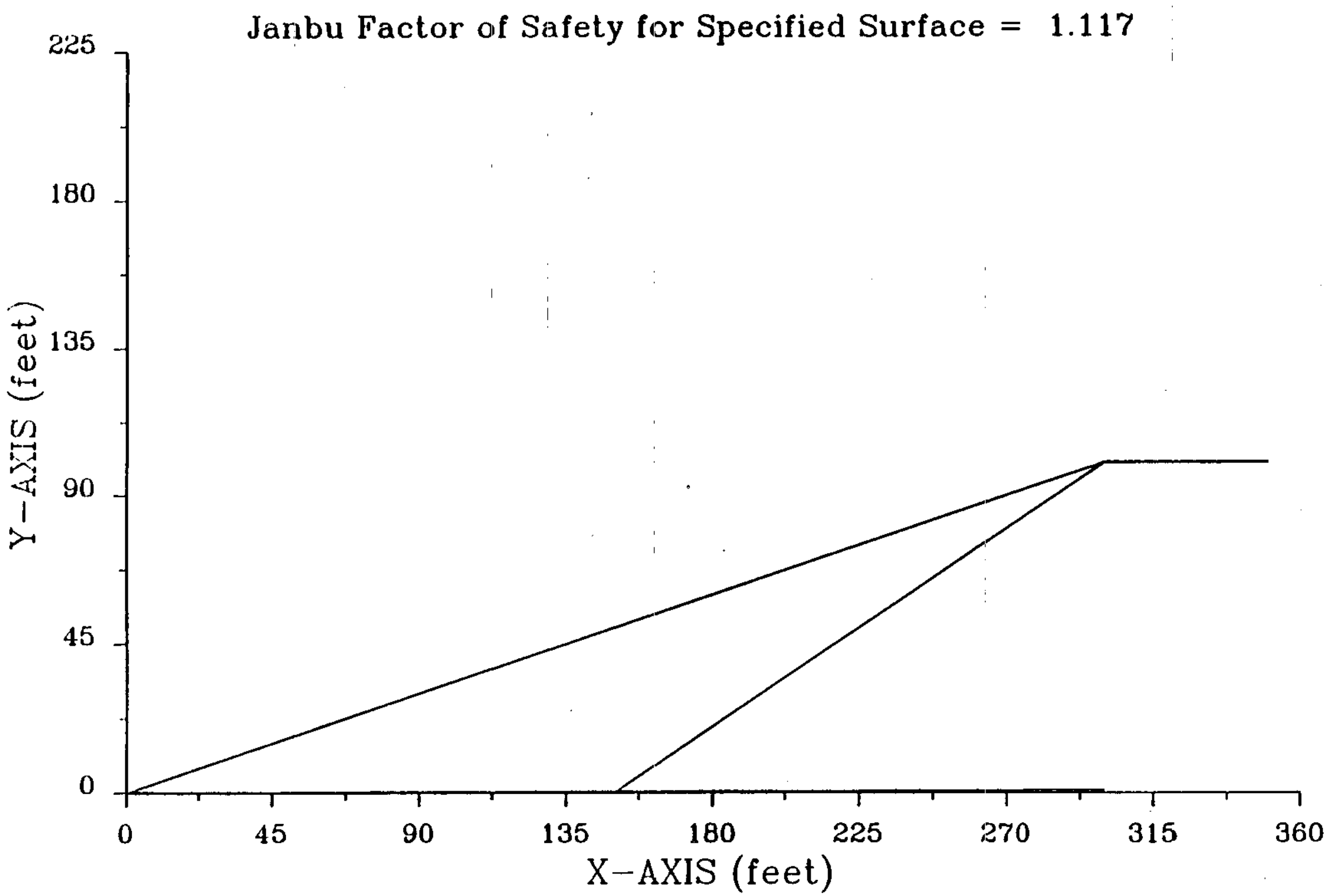
Slice	Sigma (psf)	phi	c-value (psf)	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	3000.0	20.00	.0	.0	.0	.0	.00
2	4884.8	20.00	.0	.0	.0	.0	.00
3	2199.2	30.00	.0	.0	.0	.0	.00

For the single specified surface,
Corrected JANBU factor of safety = 1.117 (Fo factor =1.037)

Resisting Shear Strength = 393.15E+03 lb
Total Driving Shear Force = 365.04E+03 lb

TOS2 10-01-93 11:09

Figure A2



XSTABL File: TOS3 10-01-93 11:49

Analysis A3

```
*****************************************
*                XSTABL                 *
*                                       *
*     Slope Stability Analysis using    *
*   Simplified BISHOP or JANBU methods  *
*                                       *
*          Copyright (C) 1992           *
*   Interactive Software Designs, Inc.  *
*          All Rights Reserved          *
*                                       *
*                                       *
*        Golder Associates, Inc.        *
*          Redmond,  WA 98052           *
*                                       *
*  Ver. 4.10                      1015  *
*****************************************
```

Problem Description :

SEGMENT BOUNDARY COORDINATES

2 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	50.0	.0	200.0	50.0	1
2	200.0	50.0	350.0	50.0	1

2 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	50.0	.0	200.0	1.0	2
2	200.0	1.0	350.0	50.0	3

ISOTROPIC Soil Parameters

3 type(s) of soil

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	120.0	120.0	.0	30.00	.000	.0	0
2	120.0	120.0	.0	20.00	.000	.0	0
3	120.0	120.0	.0	14.00	.000	.0	0

Trial failure surface specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	50.00	.00
2	200.00	.00
3	350.00	50.00

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION :
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	125.00	.00	25.000	150.000	.000	18.435	450000.1
2	275.00	25.00	25.000	150.000	18.435	.000	449999.9

SLICE INFORMATION ... continued :

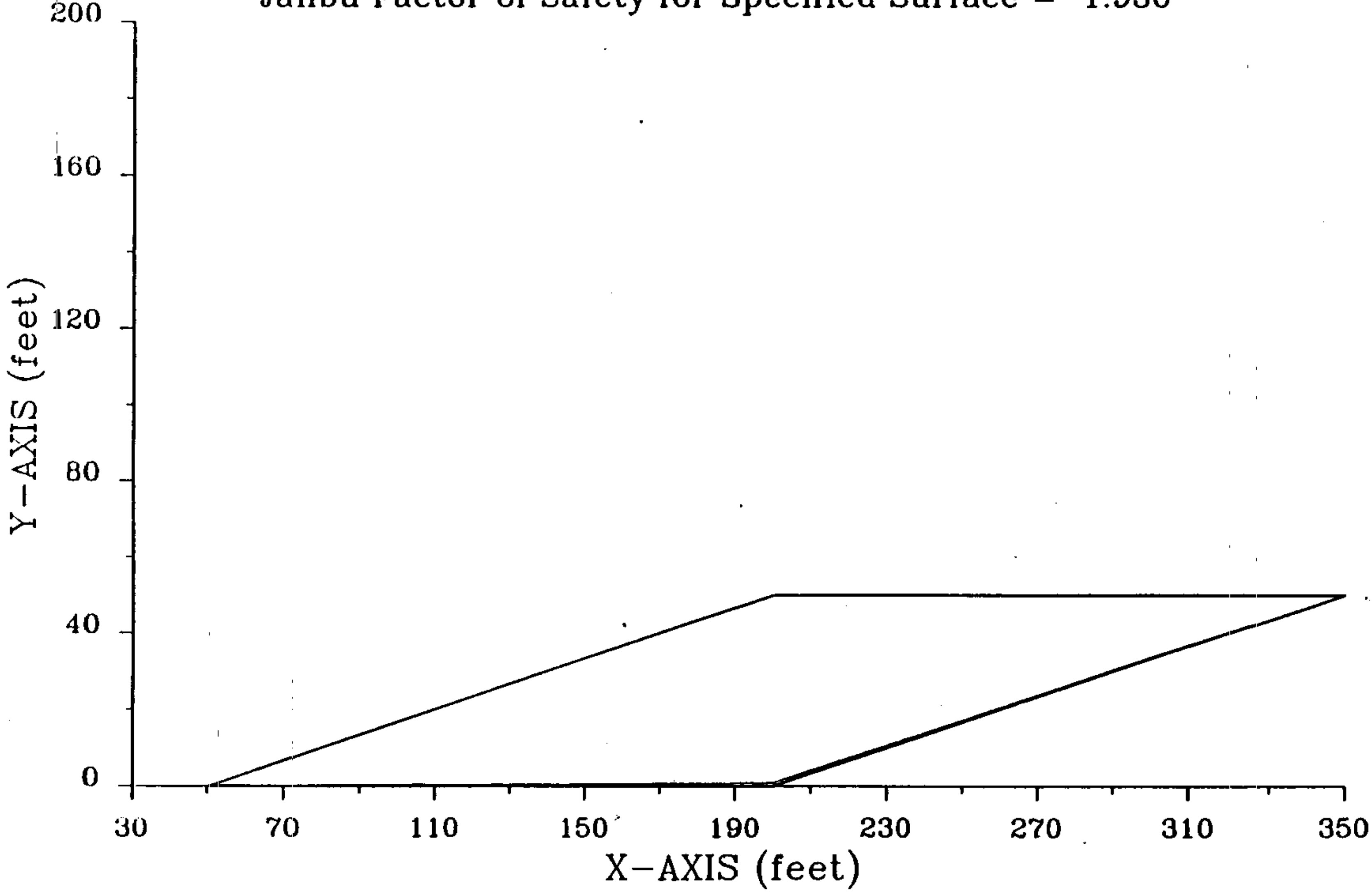
Slice	Sigma (psf)	phi	c-value (psf)	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	3000.0	20.00	.0	.0	.0	.0	.00
2	2873.5	14.00	.0	.0	.0	.0	.00

For the single specified surface,
Corrected JANBU factor of safety = 1.930 (Fo factor =1.022)

Resisting Shear Strength = 277.07E+03 lb
Total Driving Shear Force = 146.75E+03 lb

Figure A-3

Janbu Factor of Safety for Specified Surface = 1.930



XSTABL File: TOS4 10-01-93 11:28

Analysis A4

```
*****************************************
*                XSTABL                 *
*                                       *
*    Slope Stability Analysis using     *
*  Simplified BISHOP or JANBU methods   *
*                                       *
*          Copyright (C) 1992           *
*   Interactive Software Designs, Inc.  *
*          All Rights Reserved          *
*                                       *
*                                       *
*        Golder Associates, Inc.        *
*         Redmond,  WA 98052            *
*                                       *
*  Ver. 4.10                      1015  *
*****************************************
```

Problem Description :

SEGMENT BOUNDARY COORDINATES

2 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	50.0	.0	200.0	50.0	1
2	200.0	50.0	350.0	50.0	1

2 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	50.0	.0	200.0	1.0	2
2	200.0	1.0	350.0	50.0	3

ISOTROPIC Soil Parameters

3 type(s) of soil

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	120.0	120.0	.0	30.00	.000	.0	0
2	120.0	120.0	.0	20.00	.000	.0	0
3	120.0	120.0	.0	14.00	.000	.0	0

A horizontal earthquake loading coefficient
of .120 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

Trial failure surface specified by 3 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	50.00	.00
2	200.00	.00
3	350.00	50.00

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION :
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	125.00	.00	25.000	150.000	.000	18.435	450000.1
2	275.00	25.00	25.000	150.000	18.435	.000	449999.9

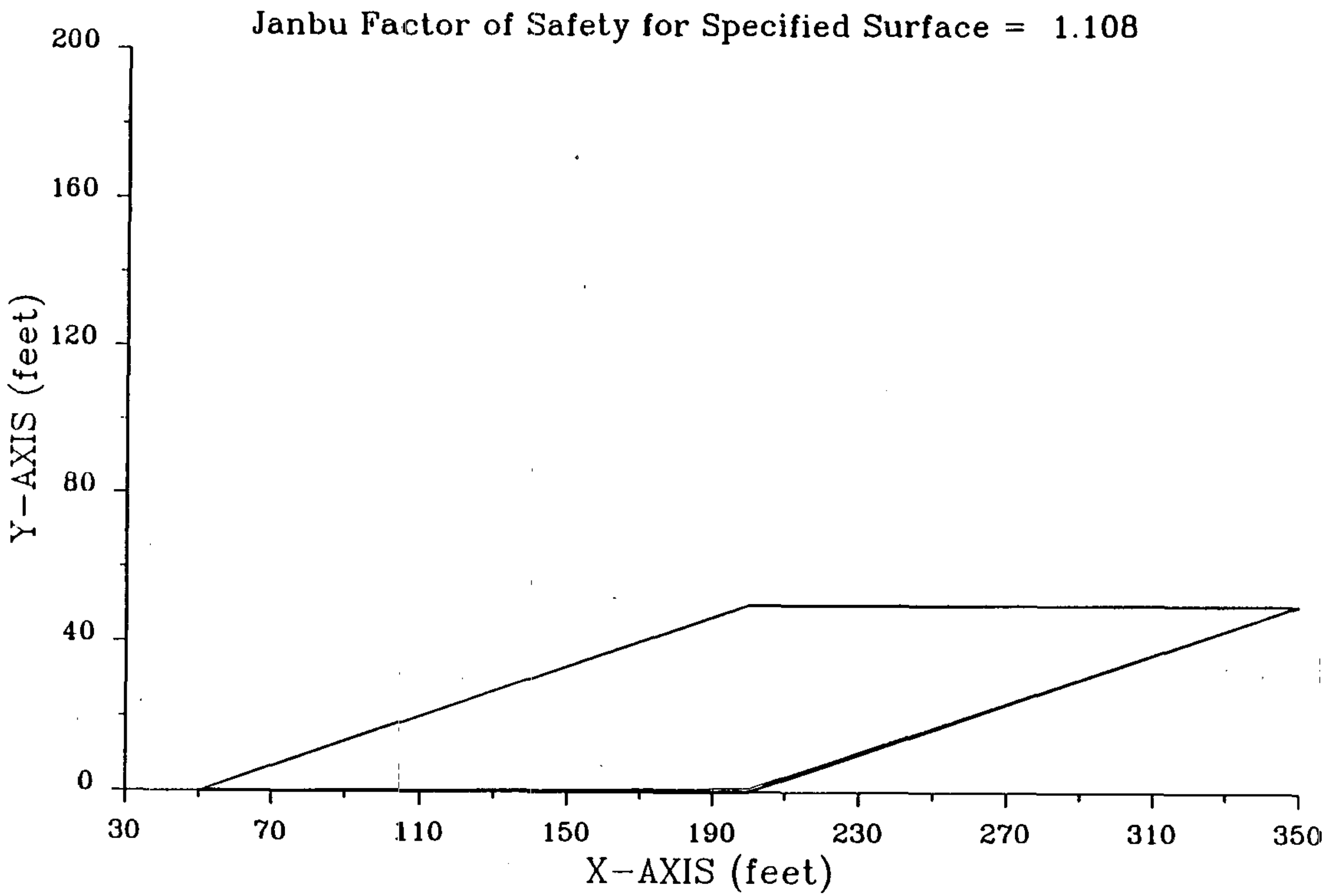
SLICE INFORMATION ... continued :

Slice	Sigma (psf)	phi	c-value (psf)	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	3000.0	20.00	.0	.0	.0	.0	.00
2	2786.3	14.00	.0	.0	.0	.0	.00

For the single specified surface,
Corrected JANBU factor of safety = 1.108 (Fo factor =1.022)

Resisting Shear Strength = 273.63E+03 lb
Total Driving Shear Force = 252.52E+03 lb

Figure A4



Sheet 20 of 20

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX B

WASTE CAPACITY

THIS PAGE INTENTIONALLY
LEFT BLANK

Golder Associates	SUBJECT Cumulative Volume		
	Job No. 923-6046	Made by FCS	Date 11-22-93
	Ref. ERDF	Checked [illegible]	Sheet 1 of 2
		Reviewed	

General Assumptions:

1. Cell is "full" when toe of lower bench is 100 ft from edge of cell.
2. 100 ft-wide bench on 35' lift between toe of upper layer and crest of lower layer slope
3. 3H:1V slopes
4. Details as in Trench Operations Study

A. Cells 1 + 2

Elev	Area	Volume
0	430,777 ft² ✓	589,779 yd³ ✓
35	479,604 ✓	
35	360,025 ✓	490,386 yd³ ✓
70	396,870 ✓	

Total: 1,080,165 yd³ ✓

Use $\text{Vol} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$

for all calc. Perform on Lotus spread sheet

B. Cells 1, 2, + 3

Elev	Area	Volume
0	572,692 ft² ✓	762,932 yd³ ✓
35	604,546 ✓	
35	363,465 ✓	494,791 yd³ ✓
70	4[illegible],[illegible]06 ✓	

Golder Associates	SUBJECT Cumulative Volume		
	Job No. 923-E046	Made by FSS	Date 11-22-93
	Ref. – ERDF	Checked BDY	Sheet 2 of 2
		Reviewed	

Total: 1,257,713 yd^3

C. Cells 1, 2, 3, + 4

Elev.	Area	
0	872,692 ft^2	1,218,893 yd^3
35	1,009,546	
35	860,462	1,152,488 yd^3
70	917,972	

Total: 2,371,381 yd^3

D. Cells 1 thru 6

Elev.	Area	
0	1,311,104 ft^2	1,789,457 yd^3
35	1,450,954	
35	1,257,796	1,674,459 yd^3
70	1,3[illegible],965	

Total: 3,463,916 yd^3

APPENDIX C

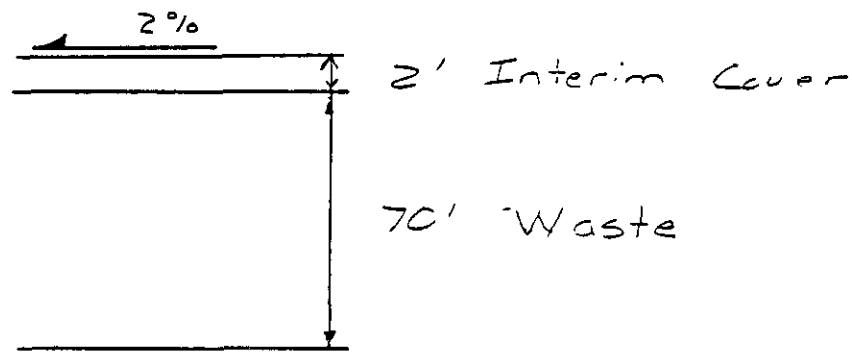
LEACHATE GENERATION

THIS PAGE INTENTIONALLY
LEFT BLANK

Golder Associates	SUBJECT Help Modeling For ERDF		
	Job No. 923-E046 Ref.	Made by RPL Checked FSS Reviewed	Date 10-19-93 Sheet 1 of 8

Problem: Estimate Leachate Production for ERDF prior to construction of The Hanford Barrier, using HELP model, version 2.05

Given:



Assumptions:

Interim Cover: Sand

Waste: Gravelly Sand

Input For HELP: Soil Parameters

Sand –

* * Porosity = 0.437
* * Field Capacity = 0.062
* * Wilting Point = 0.024
* △ Initial Soil W.C. = 0.05
* △ Hydraulic Conductivity = 1×10^{-3} cm/s
  1×10^{-4} cm/s
  1×10^{-5} cm/s

* – HELP Defaults for SAND

△ – Assumed values

Golder Associates	SUBJECT Help Modeling For ERDF		
	Job No. 923-E046 Ref.	Made by RDL Checked FSS Reviewed	Date 10-19-93 Sheet 2 of 8

Input For Help (cont'd) → Soil Parameters (Cont'd)

Waste –

- * Porosity = 0.417
- * Field Capacity = 0.045
- * Wilting Point = 0.020
- △ Initial Soil W.C. = 0.045
- \+ Hydraulic Conductivity = 0.16 cm/s

* HELP Defaults for Gravelly Sand

△ Assumed value

\+ WHC, 1993[1] test value

→ General Simulation Parameters

SCS Runoff Curve - (SCS, 1986)

- Use Bare Soil, Hydrologic Soil group A

CN = 77

Area of Cover

- Unit Area of 1 Acre (43,560 ft²)

Evaporative Zone Depth

- 18 inches (assumed)

(1) WHC, 1993, The Results of Laboratory Tests to Determine the Physical Properties of Various Barrier Construction Materials, WHC-SD-ER-DP-004, Rev. 0, Westinghouse Hanford Co., Richland, WA

Golder Associates	SUBJECT Help Modeling For ERDF		
	Job No. 923-E046	Made by RDL	Date 10-19-93
	Ref.	Checked FSS	Sheet 3 of 8
		Reviewed	

→ Climatological Data

- Synthetic Daily Temperature and solar radiation For Yakima (using HELP Data base)
- User specified Rainfall data from Hanford For 1979 to 1988

Results: Three HELP runs for 10 yr period. Detailed monthly output + Summary table Attached.

Summary For Runs 1-3, 1979 to 1988
Average yearly Values For Time Period

Top Layer K(cm/s)	Precip. (in)	Runoff (in)	Evapo. (in)	Perc. (in)	Change in storage (in)
10^{-3}	7.08	0	6.047	1.127	-0.096
10^{-4}	7.08	0	6.126	0.995	-0.037
10^{-5}	7.08	0.391	6.137	0.681	-0.125

Sheet 4 of 8

Table 1, Interim Cover Hydraulic Conductivity = 1×10^{-3} cm/s

Year	Precipitation (in)	Runoff (in)	Evapotranspiration (in)	Percolation at Bottom (in)	Change in Storage (in)
1979	5.63	0	4.443	1.046	0.144
1980	9.70	0	7.962	1.031	0.707
1981	7.04	0	6.314	0.953	-0.228
1982	8.07	0	6.728	0.865	0.477
1983	11.07	0	7.833	0.813	2.424
1984	7.27	0	6.98	0.900	-0.610
1985	5.12	0	4.659	1.492	-1.031
1986	6.93	0	5.648	1.635	-0.352
1987	5.62	0	5.230	1.347	-0.958
1988	4.39	0	4.673	1.186	-1.469
Yearly Average	7.08	0	6.047	1.127	-0.090

Table 2, Interim Cover Hydraulic Conductivity = 1 x 10^{-4} cm/s

Year	Precipitation (in)	Runoff (in)	Evapotranspiration (in)	Percolation at Bottom (in)	Change in Storage (in)
1979	5.63	0	4.440	1.046	0.144
1980	9.70	0	7.965	1.031	0.705
1981	7.04	0	6.419	0.945	-0.324
1982	8.07	0	6.722	0.818	0.531
1983	11.07	0	7.833	0.703	2.534
1984	7.27	0	7.491	0.656	-0.877
1985	5.12	0	4.796	0.991	-0.666
1986	6.93	0	5.356	1.441	0.133
1987	5.62	0	5.409	1.265	-1.054
1988	4.39	0	4.827	1.056	-1.493
Yearly Average	7.08	0	6.126	0.995	-0.037

Table 3, Interim Cover Hydraulic Conductivity = 1 x 10^{-5} cm/s

Year	Precipitation (in)	Runoff (in)	Evapotranspiration (in)	Percolation at Bottom (in)	Change in Storage (in)
1979	5.63	0.079	4.440	1.046	0.065
1980	9.70	1.086	8.078	1.031	-0.495
1981	7.04	0.544	6.419	0.944	-0.867
1982	8.07	0.595	6.722	0.815	-0.062
1983	11.07	0.741	7.833	0.688	1.807
1984	7.27	0.193	7.491	0.584	-0.998
1985	5.12	0.130	4.796	0.499	-0.305
1986	6.93	0.193	5.356	0.436	0.946
1987	5.62	0.235	5.409	0.394	-0.418
1988	4.39	0.109	4.827	0.376	-0.921
Yearly Average	7.08	0.391	6.137	0.681	-0.125

Sheet 7 of 8

United States
Department of
Agriculture

Soil
Conservation
Service

Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

Table 2-2b.—Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group—			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1]Average runoff condition, and $I_a = 0.2S$.
[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.
[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.
Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Run1.out
Sheet 1 of 14

```
******************************************************************************
******************************************************************************

 ERSF LEACHATE GENERATION STUDY
 HANFORD WASHINGTON
 10/18/93

******************************************************************************
******************************************************************************


                                LAYER  1
                                --------

                       VERTICAL PERCOLATION LAYER
  THICKNESS                                  =    24.00 INCHES
  POROSITY                                   =     0.4370 VOL/VOL
  FIELD CAPACITY                             =     0.0620 VOL/VOL
  WILTING POINT                              =     0.0240 VOL/VOL
  INITIAL SOIL WATER CONTENT                 =     0.0500 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY           =     0.001000000047 CM/SEC


                                LAYER  2
                                --------

                       VERTICAL PERCOLATION LAYER
  THICKNESS                                  =   120.00 INCHES
  POROSITY                                   =     0.4170 VOL/VOL
  FIELD CAPACITY                             =     0.0450 VOL/VOL
  WILTING POINT                              =     0.0200 VOL/VOL
  INITIAL SOIL WATER CONTENT                 =     0.0450 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY           =     0.159999996424 CM/SEC


                                LAYER  3
                                --------

                       VERTICAL PERCOLATION LAYER
  THICKNESS                                  =   120.00 INCHES
  POROSITY                                   =     0.4170 VOL/VOL
  FIELD CAPACITY                             =     0.0450 VOL/VOL
  WILTING POINT                              =     0.0200 VOL/VOL
  INITIAL SOIL WATER CONTENT                 =     0.0450 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY           =     0.159999996424 CM/SEC
```

Sheet 2 of 14

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 8

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL

Sheet 3 of 14

INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.159999996424 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	77.00
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	18.00 INCHES
UPPER LIMIT VEG. STORAGE	=	7.8660 INCHES
INITIAL VEG. STORAGE	=	0.9000 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	39.0000 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR YAKIMA WASHINGTON

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	124
END OF GROWING SEASON (JULIAN DATE)	=	276

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.20	36.10	41.90	49.20	57.30	64.50
70.40	68.60	60.90	49.90	38.20	31.50

****

MONTHLY TOTALS FOR YEAR 79

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.54	0.17	0.54	0.52	0.10	0.00
	0.09	0.38	0.20	0.67	1.43	0.99
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.813	0.365	0.165	0.391	0.204	0.172
	0.167	0.167	0.141	0.626	0.707	0.521
PERCOLATION FROM LAYER 8 (INCHES)	0.0888	0.0802	0.0888	0.0860	0.0838	0.0360
	0.0888	0.0888	0.0859	0.0888	0.0859	0.0837

****

****

ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.63	20437.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.440	16117.	78.86
PERCOLATION FROM LAYER 8	1.0457	3796.	18.57
CHANGE IN WATER STORAGE	0.144	524.	2.56
SOIL WATER AT START OF YEAR	39.00	141570.	
SOIL WATER AT END OF YEAR	39.14	142094.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 80

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.32	1.30	0.30	0.86	1.43	0.96
	0.00	0.02	0.85	0.33	0.44	1.89
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.443	1.272	1.106	0.581	1.460	0.811
	0.300	0.234	0.756	0.394	0.269	0.336
PERCOLATION FROM LAYER 8 (INCHES)	0.0886	0.0828	0.0884	0.0854	0.0880	0.0849
	0.0874	0.0871	0.0839	0.0862	0.0829	0.0852

****

****

ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.70	35211.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.962	28903.	82.09
PERCOLATION FROM LAYER 8	1.0307	3742.	10.63
CHANGE IN WATER STORAGE	0.707	2566.	7.29
SOIL WATER AT START OF YEAR	39.14	142094.	
SOIL WATER AT END OF YEAR	39.85	144660.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

MONTHLY TOTALS FOR YEAR 81

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.56	0.60	0.70	0.02	0.99	0.43
	0.19	0.03	0.60	0.39	1.08	1.45
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.757	1.243	0.591	0.277	0.984	0.504
	0.292	0.233	0.091	0.176	0.565	0.600
PERCOLATION FROM LAYER 8 (INCHES)	0.0846	0.0759	0.0834	0.0801	0.0821	0.0787
	0.0807	0.0800	0.0767	0.0786	0.0754	0.0772

ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.04	25555.	100.00
RUNOFF	0.000	0.	0.00

Sheet 6 of 14

EVAPOTRANSPIRATION	6.314	22921.	89.69
PERCOLATION FROM LAYER 8	0.9533	3460.	13.54
CHANGE IN WATER STORAGE	-0.228	-826.	-3.23
SOIL WATER AT START OF YEAR	39.85	144660.	
SOIL WATER AT END OF YEAR	39.62	143834.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 82

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.38	0.57	0.30	0.75	0.28	0.75
	0.22	0.20	0.55	1.37	0.91	1.79
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.721	0.723	0.403	0.936	0.342	0.592
	0.207	0.189	0.360	0.550	1.088	0.618
PERCOLATION FROM LAYER 8 (INCHES)	0.0766	0.0686	0.0753	0.0723	0.0742	0.0712
	0.0731	0.0726	0.0697	0.0716	0.0689	0.0708

****

****

ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.07	29294.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	6.728	24423.	83.37
PERCOLATION FROM LAYER 8	0.8648	3139.	10.72
CHANGE IN WATER STORAGE	0.477	1732.	5.91

SOIL WATER AT START OF YEAR	39.62	143834.	
SOIL WATER AT END OF YEAR	40.10	145566.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 83

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.44	1.36	1.00	0.42	0.52	0.68
	0.31	0.12	0.46	0.52	2.12	2.12
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.674	1.241	1.780	0.380	0.565	0.523
	0.199	0.183	0.738	0.431	0.606	0.515
PERCOLATION FROM LAYER 8 (INCHES)	0.0704	0.0633	0.0697	0.0672	0.0692	0.0667
	0.0687	0.0685	0.0662	0.0684	0.0662	0.0686

****

****

ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.07	40184.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.833	28434.	70.76
PERCOLATION FROM LAYER 8	0.8131	2951.	7.34
CHANGE IN WATER STORAGE	2.424	8798.	21.89
SOIL WATER AT START OF YEAR	40.10	145566.	
SOIL WATER AT END OF YEAR	42.52	154364.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

Sheet 8 of 14

ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 84

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.23	0.94	1.01	0.60	0.55	0.99
	0.06	0.00	0.42	0.07	1.83	0.57
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.547	1.310	1.126	0.451	0.524	1.144
	0.626	0.008	0.126	0.202	0.243	0.673
PERCOLATION FROM LAYER 8 (INCHES)	0.0689	0.0648	0.0699	0.0684	0.0717	0.0707
	0.0747	0.0768	0.0768	0.0825	0.0836	0.0909

****

****

ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.27	26390.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	6.980	25338.	96.01
PERCOLATION FROM LAYER 8	0.8997	3266.	12.38
CHANGE IN WATER STORAGE	-0.610	-2214.	-8.39
SOIL WATER AT START OF YEAR	42.52	154364.	
SOIL WATER AT END OF YEAR	41.91	152150.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

Sheet 9 of 14

MONTHLY TOTALS FOR YEAR 85

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.34	0.82	0.36	0.01	0.12	0.15
	0.12	0.01	0.63	0.46	1.24	0.86
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.715	1.084	0.464	0.272	0.224	0.187
	0.090	0.122	0.152	0.140	0.379	0.831
PERCOLATION FROM LAYER 8 (INCHES)	0.0963	0.0921	0.1081	0.1109	0.1210	0.1231
	0.1327	0.1376	0.1369	0.1444	0.1417	0.1475

ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.12	18586.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.659	16911.	90.99
PERCOLATION FROM LAYER 8	1.4923	5417.	29.15
CHANGE IN WATER STORAGE	-1.031	-3742.	-20.14
SOIL WATER AT START OF YEAR	41.91	152150.	
SOIL WATER AT END OF YEAR	40.88	148407.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

MONTHLY TOTALS FOR YEAR 86

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.76	1.21	0.76	0.00	0.30	0.00
	0.21	0.02	0.96	0.29	0.65	0.77
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.620	1.592	0.669	0.288	0.238	0.188
	0.182	0.159	0.282	0.258	0.697	0.476
PERCOLATION FROM LAYER 8 (INCHES)	0.1478	0.1332	0.1465	0.1404	0.1433	0.1366
	0.1389	0.1364	0.1295	0.1313	0.1246	0.1264

****

****

ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	6.93	25156.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.648	20501.	81.49
PERCOLATION FROM LAYER 8	1.6349	5935.	23.59
CHANGE IN WATER STORAGE	-0.352	-1279.	-5.09
SOIL WATER AT START OF YEAR	40.88	148407.	
SOIL WATER AT END OF YEAR	40.53	147128.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 87

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.80	0.55	1.05	0.14	0.39	0.08
	0.50	0.07	0.01	0.00	0.40	1.63

RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.754	1.166	1.127	0.385	0.270	0.215
(INCHES)	0.195	0.174	0.149	0.139	0.136	0.522
PERCOLATION FROM	0.1240	0.1101	0.1199	0.1141	0.1162	0.1108
LAYER 8 (INCHES)	0.1130	0.1116	0.1068	0.1092	0.1046	0.1070

****

****

ANNUAL TOTALS FOR YEAR 87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.62	20401.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.230	18986.	93.07
PERCOLATION FROM LAYER 8	1.3472	4891.	23.97
CHANGE IN WATER STORAGE	-0.958	-3476.	-17.04
SOIL WATER AT START OF YEAR	40.53	147128.	
SOIL WATER AT END OF YEAR	39.57	143652.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.48	0.00	0.60	1.12	0.33	0.11
	0.13	0.00	0.39	0.01	0.82	0.40
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.949	0.494	0.304	0.378	0.729	0.298
(INCHES)	0.234	0.127	0.081	0.158	0.176	0.245
PERCOLATION FROM	0.1060	0.0982	0.1041	0.0998	0.1021	0.0979

LAYER 8 (INCHES)	0.1001	0.0991	0.0949	0.0969	0.0927	0.0947

****

****

ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	4.39	15936.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.673	16963.	106.45
PERCOLATION FROM LAYER 8	1.1864	4307.	27.03
CHANGE IN WATER STORAGE	-1.469	-5334.	-33.47
SOIL WATER AT START OF YEAR	39.57	143652.	
SOIL WATER AT END OF YEAR	38.10	138318.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 79 THROUGH 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.75	0.66	0.44	0.50	0.42
	0.18	0.09	0.51	0.41	1.09	1.25
STD. DEVIATIONS	0.53	0.46	0.29	0.40	0.41	0.40
	0.14	0.12	0.28	0.40	0.57	0.60
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						

TOTALS	0.699	1.049	0.774	0.484	0.554	0.463
	0.249	0.160	0.288	0.307	0.487	0.534
STD. DEVIATIONS	0.141	0.392	0.499	0.242	0.408	0.322
	0.145	0.065	0.257	0.181	0.300	0.165

PERCOLATION FROM LAYER 8

TOTALS	0.0952	0.0869	0.0954	0.0925	0.0957	0.0927
	0.0958	0.0958	0.0927	0.0958	0.0927	0.0957
STD. DEVIATIONS	0.0249	0.0221	0.0245	0.0236	0.0245	0.0239
	0.0249	0.0251	0.0244	0.0253	0.0244	0.0250

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 79 THROUGH 88

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	7.08	(2.085)	25715.	100.00
RUNOFF	0.000	(0.000)	0.	0.00
EVAPOTRANSPIRATION	6.047	(1.312)	21950.	85.36
PERCOLATION FROM LAYER 8	1.1268	(0.2806)	4090.	15.91
CHANGE IN WATER STORAGE	-0.090	(1.117)	-325.	-1.26

PEAK DAILY VALUES FOR YEARS 79 THROUGH 88

	(INCHES)	(CU. FT.)
PRECIPITATION	0.93	3375.9
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 8	0.0048	17.3
SNOW WATER	0.75	2734.6
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1830	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240	

****

FINAL WATER STORAGE AT END OF YEAR 88

LAYER	(INCHES)	(VOL/VOL)
1	1.88	0.0785
2	4.78	0.0398
3	4.96	0.0414
4	5.11	0.0426
5	5.23	0.0436
6	5.32	0.0443
7	5.39	0.0449
8	5.43	0.0453
SNOW WATER	0.00	

****
****

Run 2.out
Sheet 1 of 14

```
***************************************************************************
***************************************************************************

ERDF LEACHATE GENERATION STUDY
HANFORD WASHINGTON
10\19\93

***************************************************************************
***************************************************************************


                         LAYER  1
                         --------

               VERTICAL PERCOLATION LAYER
  THICKNESS                              =      24.00 INCHES
  POROSITY                               =       0.4370 VOL/VOL
  FIELD CAPACITY                         =       0.0620 VOL/VOL
  WILTING POINT                          =       0.0240 VOL/VOL
  INITIAL SOIL WATER CONTENT             =       0.0500 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY       =       0.000099999997 CM/SEC


                         LAYER  2
                         --------

               VERTICAL PERCOLATION LAYER
  THICKNESS                              =     120.00 INCHES
  POROSITY                               =       0.4170 VOL/VOL
  FIELD CAPACITY                         =       0.0450 VOL/VOL
  WILTING POINT                          =       0.0200 VOL/VOL
  INITIAL SOIL WATER CONTENT             =       0.0450 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY       =       0.159999996424 CM/SEC


                         LAYER  3
                         --------

               VERTICAL PERCOLATION LAYER
  THICKNESS                              =     120.00 INCHES
  POROSITY                               =       0.4170 VOL/VOL
  FIELD CAPACITY                         =       0.0450 VOL/VOL
  WILTING POINT                          =       0.0200 VOL/VOL
  INITIAL SOIL WATER CONTENT             =       0.0450 VOL/VOL
  SATURATED HYDRAULIC CONDUCTIVITY       =       0.159999996424 CM/SEC
```

```
                              LAYER  4
                              --------

                   VERTICAL PERCOLATION LAYER
THICKNESS                              =   120.00 INCHES
POROSITY                               =     0.4170 VOL/VOL
FIELD CAPACITY                         =     0.0450 VOL/VOL
WILTING POINT                          =     0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT             =     0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =     0.159999996424 CM/SEC


                              LAYER  5
                              --------

                   VERTICAL PERCOLATION LAYER
THICKNESS                              =   120.00 INCHES
POROSITY                               =     0.4170 VOL/VOL
FIELD CAPACITY                         =     0.0450 VOL/VOL
WILTING POINT                          =     0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT             =     0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =     0.159999996424 CM/SEC


                              LAYER  6
                              --------

                   VERTICAL PERCOLATION LAYER
THICKNESS                              =   120.00 INCHES
POROSITY                               =     0.4170 VOL/VOL
FIELD CAPACITY                         =     0.0450 VOL/VOL
WILTING POINT                          =     0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT             =     0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =     0.159999996424 CM/SEC


                              LAYER  7
                              --------

                   VERTICAL PERCOLATION LAYER
THICKNESS                              =   120.00 INCHES
POROSITY                               =     0.4170 VOL/VOL
FIELD CAPACITY                         =     0.0450 VOL/VOL
WILTING POINT                          =     0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT             =     0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =     0.159999996424 CM/SEC


                              LAYER  8
                              --------

                   VERTICAL PERCOLATION LAYER
THICKNESS                              =   120.00 INCHES
POROSITY                               =     0.4170 VOL/VOL
FIELD CAPACITY                         =     0.0450 VOL/VOL
WILTING POINT                          =     0.0200 VOL/VOL
```

INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	77.00
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	18.00 INCHES
UPPER LIMIT VEG. STORAGE	=	7.8660 INCHES
INITIAL VEG. STORAGE	=	0.9000 INCHES
~~INITIAL SNOW WATER CONTENT~~	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	39.0000 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR YAKIMA WASHINGTON

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	124
END OF GROWING SEASON (JULIAN DATE)	=	276

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.20	36.10	41.90	49.20	57.30	64.50
70.40	68.60	60.90	49.90	38.20	31.50

****

MONTHLY TOTALS FOR YEAR 79

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.54	0.17	0.54	0.52	0.10	0.00
	0.09	0.38	0.20	0.67	1.43	0.99
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.813	0.365	0.165	0.391	0.204	0.172
	0.167	0.167	0.141	0.626	0.707	0.521
PERCOLATION FROM LAYER 8 (INCHES)	0.0888	0.0802	0.0888	0.0860	0.0888	0.0860
	0.0888	0.0888	0.0859	0.0888	0.0859	0.0887

****

****

ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.63	20437.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.440	16118.	78.87
PERCOLATION FROM LAYER 8	1.0457	3796.	18.57
CHANGE IN WATER STORAGE	0.144	523.	2.56
SOIL WATER AT START OF YEAR	39.00	141570.	
SOIL WATER AT END OF YEAR	39.14	142093.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 80

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.32	1.30	0.30	0.86	1.43	0.96
	0.00	0.02	0.85	0.33	0.44	1.89
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.443	1.268	1.107	0.583	1.461	0.812
	0.300	0.234	0.757	0.395	0.270	0.336
PERCOLATION FROM LAYER 8 (INCHES)	0.0886	0.0828	0.0884	0.0854	0.0880	0.0849
	0.0874	0.0871	0.0838	0.0862	0.0829	0.0851

****

****

Sheet 5 of 14

ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.70	35211.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.965	28912.	82.11
PERCOLATION FROM LAYER 8	1.0306	3741.	10.62
CHANGE IN WATER STORAGE	0.705	2558.	7.26
SOIL WATER AT START OF YEAR	39.14	142093.	
SOIL WATER AT END OF YEAR	39.85	144651.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 81

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.56	0.60	0.70	0.02	0.99	0.43
	0.19	0.03	0.60	0.39	1.08	1.45
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.757	1.243	0.592	0.277	0.984	0.505
	0.292	0.233	0.194	0.175	0.567	0.602
PERCOLATION FROM LAYER 8 (INCHES)	0.0845	0.0757	0.0832	0.0798	0.0816	0.0782
	0.0800	0.0791	0.0757	0.0773	0.0739	0.0755

****

****

ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.04	25555.	100.00
RUNOFF	0.000	0.	0.00

Sheet 6 of 14

EVAPOTRANSPIRATION	6.419	23302.	91.18
PERCOLATION FROM LAYER 8	0.9445	3428.	13.42
CHANGE IN WATER STORAGE	-0.324	-1175.	-4.60
SOIL WATER AT START OF YEAR	39.85	144651.	
SOIL WATER AT END OF YEAR	39.52	143476.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

MONTHLY TOTALS FOR YEAR 82

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.38	0.57	0.30	0.75	0.28	0.75
	0.22	0.20	0.55	1.37	0.91	1.79
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.724	0.720	0.401	0.934	0.341	0.591
(INCHES)	0.207	0.189	0.359	0.550	1.088	0.618
PERCOLATION FROM	0.0745	0.0665	0.0727	0.0694	0.0708	0.0676
LAYER 8 (INCHES)	0.0690	0.0680	0.0650	0.0663	0.0633	0.0646

ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.07	29294.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	6.722	24400.	83.29
PERCOLATION FROM LAYER 8	0.8177	2968.	10.13
CHANGE IN WATER STORAGE	0.531	1926.	6.57

SOIL WATER AT START OF YEAR	39.52	143476.	
SOIL WATER AT END OF YEAR	40.06	145402.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 83

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.44	1.36	1.00	0.42	0.52	0.68
	0.31	0.12	0.46	0.52	2.12	2.12
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.674	1.241	1.780	0.380	0.565	0.523
	0.199	0.183	0.738	0.431	0.606	0.515
PERCOLATION FROM LAYER 8 (INCHES)	0.0637	0.0568	0.0622	0.0594	0.0607	0.0580
	0.0592	0.0585	0.0560	0.0573	0.0549	0.0562

****

****

ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.07	40184.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.833	28435.	70.76
PERCOLATION FROM LAYER 8	0.7030	2552.	6.35
CHANGE IN WATER STORAGE	2.534	9197.	22.89
SOIL WATER AT START OF YEAR	40.06	145402.	
SOIL WATER AT END OF YEAR	42.59	154598.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 84

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.23	0.94	1.01	0.60	0.55	0.99
	0.06	0.00	0.42	0.07	1.83	0.57
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.547	1.310	1.126	0.451	0.524	1.144
	0.726	0.300	0.243	0.203	0.241	0.675
PERCOLATION FROM LAYER 8 (INCHES)	0.0557	0.0518	0.0550	0.0530	0.0546	0.0528
	0.0546	0.0549	0.0536	0.0561	0.0554	0.0588

****

****

ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.27	26390.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.491	27191.	103.03
PERCOLATION FROM LAYER 8	0.6562	2382.	9.03
CHANGE IN WATER STORAGE	-0.877	-3183.	-12.06
SOIL WATER AT START OF YEAR	42.59	154598.	
SOIL WATER AT END OF YEAR	41.71	151416.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

Sheet 9 of 14

****

MONTHLY TOTALS FOR YEAR 85

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.34	0.82	0.36	0.01	0.12	0.15
	0.12	0.01	0.63	0.46	1.24	0.86
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.716	1.086	0.463	0.271	0.223	0.186
	0.171	0.155	0.171	0.140	0.378	0.835
PERCOLATION FROM LAYER 8 (INCHES)	0.0609	0.0572	0.0665	0.0680	0.0747	0.0771
	0.0850	0.0907	0.0933	0.1020	0.1037	0.1119

****

****

ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.12	18586.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.796	17408.	93.66
PERCOLATION FROM LAYER 8	0.9909	3597.	19.35
CHANGE IN WATER STORAGE	-0.666	-2419.	-13.02
SOIL WATER AT START OF YEAR	41.71	151416.	
SOIL WATER AT END OF YEAR	41.05	148996.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 86

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.76	1.21	0.76	0.00	0.30	0.00
	0.21	0.02	0.96	0.29	0.65	0.77
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.622	1.597	0.666	0.288	0.236	0.188
	0.181	0.159	0.400	0.205	0.312	0.502
PERCOLATION FROM LAYER 8 (INCHES)	0.1160	0.1077	0.1217	0.1196	0.1248	0.1213
	0.1254	0.1249	0.1200	0.1227	0.1174	0.1196

****

****

ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	6.93	25156.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.356	19441.	77.28
PERCOLATION FROM LAYER 8	1.4411	5231.	20.80
CHANGE IN WATER STORAGE	0.133	484.	1.92
SOIL WATER AT START OF YEAR	41.05	148996.	
SOIL WATER AT END OF YEAR	41.18	149480.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 87

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.80	0.55	1.05	0.14	0.39	0.08
	0.50	0.07	0.01	0.00	0.40	1.63

RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.754	1.199	1.268	0.394	0.272	0.216
	0.195	0.175	0.149	0.139	0.136	0.512
PERCOLATION FROM LAYER 8 (INCHES)	0.1178	0.1047	0.1140	0.1085	0.1101	0.1047
	0.1063	0.1044	0.0994	0.1010	0.0961	0.0978

****

****

ANNUAL TOTALS FOR YEAR 87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.62	20401.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.409	19634.	96.24
PERCOLATION FROM LAYER 8	1.2647	4591.	22.50
CHANGE IN WATER STORAGE	-1.054	-3825.	-18.75
SOIL WATER AT START OF YEAR	41.18	149480.	
SOIL WATER AT END OF YEAR	40.13	145656.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.48	0.00	0.60	1.12	0.33	0.11
	0.13	0.00	0.39	0.01	0.82	0.40
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.949	0.494	0.304	0.878	0.729	0.298
	0.234	0.195	0.178	0.158	0.169	0.240
PERCOLATION FROM	0.0963	0.0887	0.0935	0.0893	0.0910	0.0869

LAYER 8 (INCHES)	0.0887	0.0875	0.0837	0.0854	0.0817	0.0835

****

****

ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	4.39	15936.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	4.827	17521.	109.95
PERCOLATION FROM LAYER 8	1.0562	3834.	24.06
CHANGE IN WATER STORAGE	-1.493	-5419.	-34.00
SOIL WATER AT START OF YEAR	40.13	145656.	
SOIL WATER AT END OF YEAR	38.63	140237.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 79 THROUGH 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.75	0.66	0.44	0.50	0.42
	0.18	0.09	0.51	0.41	1.09	1.25
STD. DEVIATIONS	0.53	0.46	0.29	0.40	0.41	0.40
	0.14	0.12	0.28	0.40	0.57	0.60
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.700	1.052	0.787	0.485	0.554	0.463
	0.267	0.199	0.333	0.302	0.448	0.536
STD. DEVIATIONS	0.141	0.394	0.512	0.241	0.408	0.322
	0.168	0.045	0.235	0.183	0.296	0.167

PERCOLATION FROM LAYER 8

TOTALS	0.0847	0.0772	0.0846	0.0818	0.0845	0.0817
	0.0844	0.0844	0.0816	0.0843	0.0815	0.0842
STD. DEVIATIONS	0.0216	0.0195	0.0216	0.0208	0.0214	0.0205
	0.0210	0.0210	0.0203	0.0211	0.0205	0.0214

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 79 THROUGH 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.08 (2.085)	25715.	100.00
RUNOFF	0.000 (0.000)	0.	0.00
EVAPOTRANSPIRATION	6.126 (1.334)	22236.	86.47
PERCOLATION FROM LAYER 8	0.9951 (0.2388)	3612.	14.05
CHANGE IN WATER STORAGE	-0.037 (1.149)	-133.	-0.52

****

****

PEAK DAILY VALUES FOR YEARS 79 THROUGH 88

	(INCHES)	(CU. FT.)
PRECIPITATION	0.93	3375.9
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 8	0.0040	14.7
SNOW WATER	0.75	2734.6

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2271

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0240

****

****

FINAL WATER STORAGE AT END OF YEAR 88

LAYER	(INCHES)	(VOL/VOL)
1	2.53	0.1053
2	4.84	0.0404
3	5.00	0.0417
4	5.12	0.0427
5	5.20	0.0434
6	5.26	0.0439
7	5.31	0.0443
8	5.36	0.0447
SNOW WATER	0.00	

****
****

Run3.out

Sheet 1 of 14

```
************************************************************************
************************************************************************

 ERDF LEACHATE GENERATION STUDY
 HANFORD WASHINGTON
 10\19\93

************************************************************************
************************************************************************


                              LAYER  1
                              --------

                    VERTICAL PERCOLATION LAYER
   THICKNESS                              =     24.00 INCHES
   POROSITY                               =      0.4370 VOL/VOL
   FIELD CAPACITY                         =      0.0620 VOL/VOL
   WILTING POINT                          =      0.0240 VOL/VOL
   INITIAL SOIL WATER CONTENT             =      0.0500 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY       =      0.000010000000 CM/SEC


                              LAYER  2
                              --------

                    VERTICAL PERCOLATION LAYER
   THICKNESS                              =    120.00 INCHES
   POROSITY                               =      0.4170 VOL/VOL
   FIELD CAPACITY                         =      0.0450 VOL/VOL
   WILTING POINT                          =      0.0200 VOL/VOL
   INITIAL SOIL WATER CONTENT             =      0.0450 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY       =      0.159999996424 CM/SEC


                              LAYER  3
                              --------

                    VERTICAL PERCOLATION LAYER
   THICKNESS                              =    120.00 INCHES
   POROSITY                               =      0.4170 VOL/VOL
   FIELD CAPACITY                         =      0.0450 VOL/VOL
   WILTING POINT                          =      0.0200 VOL/VOL
   INITIAL SOIL WATER CONTENT             =      0.0450 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY       =      0.159999996424 CM/SEC
```

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.159999996424 CM/SEC

LAYER 8

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.159999996424 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 77.00
TOTAL AREA OF COVER = 43560. SQ FT
EVAPORATIVE ZONE DEPTH = 18.00 INCHES
UPPER LIMIT VEG. STORAGE = 7.8660 INCHES
INITIAL VEG. STORAGE = 0.9000 INCHES
INITIAL SNOW WATER CONTENT = 0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS = 39.0000 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR YAKIMA WASHINGTON

MAXIMUM LEAF AREA INDEX = 0.00
START OF GROWING SEASON (JULIAN DATE) = 124
END OF GROWING SEASON (JULIAN DATE) = 276

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.20	36.10	41.90	49.20	57.30	64.50
70.40	68.60	60.90	49.90	38.20	31.50

****

MONTHLY TOTALS FOR YEAR 79

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.54	0.17	0.54	0.52	0.10	0.00
	0.09	0.38	0.20	0.67	1.43	0.99
RUNOFF (INCHES)	0.000	0.000	0.032	0.000	0.000	0.000
	0.000	0.000	0.000	0.006	0.039	0.002
EVAPOTRANSPIRATION (INCHES)	0.813	0.365	0.165	0.391	0.204	0.172
	0.167	0.167	0.141	0.626	0.707	0.521
PERCOLATION FROM LAYER 8 (INCHES)	0.0888	0.0802	0.0888	0.0860	0.0888	0.0860
	0.0888	0.0888	0.0859	0.0888	0.0859	0.0887

****

****

ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.63	20437.	100.00
RUNOFF	0.079	286.	1.40
EVAPOTRANSPIRATION	4.440	16118.	78.87
PERCOLATION FROM LAYER 8	1.0457	3796.	18.57
CHANGE IN WATER STORAGE	0.065	237.	1.16
SOIL WATER AT START OF YEAR	39.00	141570.	
SOIL WATER AT END OF YEAR	39.07	141807.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 80

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.32	1.30	0.30	0.86	1.43	0.96
	0.00	0.02	0.85	0.33	0.44	1.89
RUNOFF (INCHES)	0.000	0.000	0.000	0.173	0.332	0.006
	0.000	0.000	0.351	0.000	0.001	0.223
EVAPOTRANSPIRATION	0.443	1.268	1.108	0.587	1.552	0.819
(INCHES)	0.300	0.235	0.757	0.399	0.274	0.336
PERCOLATION FROM	0.0886	0.0828	0.0884	0.0854	0.0880	0.0849
LAYER 8 (INCHES)	0.0874	0.0871	0.0838	0.0862	0.0829	0.0851

****

****

ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.70	35211.	100.00
RUNOFF	1.086	3943.	11.20
EVAPOTRANSPIRATION	8.078	29324.	83.28
PERCOLATION FROM LAYER 8	1.0306	3741.	10.62
CHANGE IN WATER STORAGE	-0.495	-1797.	-5.10
SOIL WATER AT START OF YEAR	39.07	141807.	
SOIL WATER AT END OF YEAR	38.57	140011.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

MONTHLY TOTALS FOR YEAR 81

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.56	0.60	0.70	0.02	0.99	0.43
	0.19	0.03	0.60	0.39	1.08	1.45
RUNOFF (INCHES)	0.000	0.000	0.105	0.000	0.306	0.000
	0.000	0.000	0.026	0.000	0.107	0.000
EVAPOTRANSPIRATION (INCHES)	0.755	1.242	0.592	0.277	0.984	0.505
	0.293	0.233	0.194	0.175	0.567	0.602
PERCOLATION FROM LAYER 8 (INCHES)	0.0845	0.0757	0.0832	0.0798	0.0816	0.0782
	0.0800	0.0791	0.0757	0.0773	0.0739	0.0754

ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.04	25555.	100.00
RUNOFF	0.544	1976.	7.73

EVAPOTRANSPIRATION	6.419	23300.	91.18
PERCOLATION FROM LAYER 8	0.9443	3428.	13.41
CHANGE IN WATER STORAGE	-0.867	-3148.	-12.32
SOIL WATER AT START OF YEAR	38.57	140011.	
SOIL WATER AT END OF YEAR	37.70	136862.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 82

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.38	0.57	0.30	0.75	0.28	0.75
	0.22	0.20	0.55	1.37	0.91	1.79
RUNOFF (INCHES)	0.000	0.000	0.000	0.031	0.000	0.003
	0.000	0.000	0.000	0.449	0.101	0.012
EVAPOTRANSPIRATION (INCHES)	0.724	0.721	0.401	0.934	0.341	0.591
	0.207	0.189	0.359	0.550	1.088	0.618
PERCOLATION FROM LAYER 8 (INCHES)	0.0744	0.0664	0.0726	0.0693	0.0707	0.0674
	0.0687	0.0678	0.0647	0.0659	0.0629	0.0640

****

****

ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.07	29294.	100.00
RUNOFF	0.595	2161.	7.38
EVAPOTRANSPIRATION	6.722	24402.	83.30
PERCOLATION FROM LAYER 8	0.8148	2958.	10.10
CHANGE IN WATER STORAGE	-0.062	-226.	-0.77

SOIL WATER AT START OF YEAR	37.70	136862.	
SOIL WATER AT END OF YEAR	37.64	136636.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 83

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.44	1.36	1.00	0.42	0.52	0.68
	0.31	0.12	0.46	0.52	2.12	2.12
RUNOFF (INCHES)	0.131	0.000	0.012	0.000	0.024	0.032
	0.000	0.000	0.000	0.000	0.309	0.233
EVAPOTRANSPIRATION (INCHES)	0.674	1.241	1.780	0.380	0.565	0.523
	0.199	0.183	0.738	0.431	0.606	0.515
PERCOLATION FROM LAYER 8 (INCHES)	0.0631	0.0562	0.0614	0.0586	0.0597	0.0569
	0.0580	0.0571	0.0545	0.0556	0.0530	0.0540

****

****

ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.07	40184.	100.00
RUNOFF	0.741	2690.	6.69
EVAPOTRANSPIRATION	7.833	28435.	70.76
PERCOLATION FROM LAYER 8	0.6880	2498.	6.22
CHANGE IN WATER STORAGE	1.807	6561.	16.33
SOIL WATER AT START OF YEAR	37.64	136636.	
SOIL WATER AT END OF YEAR	39.45	143197.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 84

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.23	0.94	1.01	0.60	0.55	0.99
	0.06	0.00	0.42	0.07	1.83	0.57
RUNOFF (INCHES)	0.000	0.000	0.067	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.126	0.000
EVAPOTRANSPIRATION (INCHES)	0.547	1.310	1.126	0.451	0.524	1.144
	0.726	0.300	0.243	0.203	0.241	0.675
PERCOLATION FROM LAYER 8 (INCHES)	0.0533	0.0491	0.0518	0.0495	0.0504	0.0481
	0.0491	0.0484	0.0462	0.0472	0.0450	0.0459

****

****

ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	7.27	26390.	100.00
RUNOFF	0.193	701.	2.66
EVAPOTRANSPIRATION	7.491	27191.	103.03
PERCOLATION FROM LAYER 8	0.5841	2120.	8.03
CHANGE IN WATER STORAGE	-0.998	-3622.	-13.73
SOIL WATER AT START OF YEAR	39.45	143197.	
SOIL WATER AT END OF YEAR	38.45	139575.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 85

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.34	0.82	0.36	0.01	0.12	0.15
	0.12	0.01	0.63	0.46	1.24	0.86
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.119	0.011
EVAPOTRANSPIRATION (INCHES)	0.716	1.086	0.463	0.271	0.223	0.186
	0.171	0.155	0.171	0.140	0.378	0.835
PERCOLATION FROM LAYER 8 (INCHES)	0.0453	0.0404	0.0442	0.0423	0.0431	0.0412
	0.0421	0.0416	0.0397	0.0406	0.0388	0.0397

****

****

ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.12	18586.	100.00
RUNOFF	0.130	473.	2.54
EVAPOTRANSPIRATION	4.796	17408.	93.66
PERCOLATION FROM LAYER 8	0.4991	1812.	9.75
CHANGE IN WATER STORAGE	-0.305	-1107.	-5.95
SOIL WATER AT START OF YEAR	38.45	139575.	
SOIL WATER AT END OF YEAR	38.15	138468.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 86

Sheet 10 of 14

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	1.76	1.21	0.76	0.00	0.30	0.00
	0.21	0.02	0.96	0.29	0.65	0.77
RUNOFF (INCHES)	0.025	0.013	0.000	0.000	0.000	0.000
	0.000	0.000	0.155	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.622	1.597	0.666	0.288	0.236	0.188
	0.181	0.159	0.400	0.205	0.312	0.502
PERCOLATION FROM LAYER 8 (INCHES)	0.0392	0.0350	0.0384	0.0367	0.0376	0.0360
	0.0368	0.0364	0.0349	0.0357	0.0343	0.0351

****

****

ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	6.93	25156.	100.00
RUNOFF	0.193	699.	2.78
EVAPOTRANSPIRATION	5.356	19441.	77.28
PERCOLATION FROM LAYER 8	0.4361	1583.	6.29
CHANGE IN WATER STORAGE	0.946	3433.	13.65
SOIL WATER AT START OF YEAR	38.15	138468.	
SOIL WATER AT END OF YEAR	39.09	141901.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 87

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.80	0.55	1.05	0.14	0.39	0.08
	0.50	0.07	0.01	0.00	0.40	1.63

RUNOFF (INCHES)	0.000	0.013	0.047	0.000	0.000	0.000
	0.003	0.000	0.000	0.000	0.000	0.172
EVAPOTRANSPIRATION (INCHES)	0.754	1.199	1.268	0.394	0.272	0.216
	0.195	0.175	0.149	0.139	0.136	0.512
PERCOLATION FROM LAYER 8 (INCHES)	0.0348	0.0312	0.0343	0.0329	0.0338	0.0324
	0.0333	0.0331	0.0318	0.0327	0.0315	0.0324

****

****

ANNUAL TOTALS FOR YEAR 87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	5.62	20401.	100.00
RUNOFF	0.235	853.	4.18
EVAPOTRANSPIRATION	5.409	19634.	96.24
PERCOLATION FROM LAYER 8	0.3943	1431.	7.02
CHANGE IN WATER STORAGE	-0.418	-1518.	-7.44
SOIL WATER AT START OF YEAR	39.09	141901.	
SOIL WATER AT END OF YEAR	38.67	140384.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

MONTHLY TOTALS FOR YEAR 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.48	0.00	0.60	1.12	0.33	0.11
	0.13	0.00	0.39	0.01	0.32	0.40
RUNOFF (INCHES)	0.000	0.000	0.000	0.105	0.004	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.949	0.494	0.304	0.878	0.729	0.298
	0.234	0.195	0.178	0.158	0.159	0.240
PERCOLATION FROM	0.0323	0.0301	0.0320	0.0309	0.0318	0.0307

LAYER 8 (INCHES)	0.0317	0.0317	0.0306	0.0316	0.0306	0.0316

****

****

ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	4.39	15936.	100.00
RUNOFF	0.109	396.	2.48
EVAPOTRANSPIRATION	4.827	17521.	109.95
PERCOLATION FROM LAYER 8	0.3756	1363.	8.56
CHANGE IN WATER STORAGE	-0.921	-3344.	-20.98
SOIL WATER AT START OF YEAR	38.67	140384.	
SOIL WATER AT END OF YEAR	37.75	137040.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 79 THROUGH 88

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.75	0.66	0.44	0.50	0.42
	0.18	0.09	0.51	0.41	1.09	1.25
STD. DEVIATIONS	0.53	0.46	0.29	0.40	0.41	0.40
	0.14	0.12	0.28	0.40	0.57	0.60
RUNOFF						
TOTALS	0.016	0.003	0.026	0.031	0.067	0.004
	0.000	0.000	0.053	0.046	0.080	0.065
STD. DEVIATIONS	0.041	0.005	0.036	0.060	0.133	0.010
	0.001	0.000	0.115	0.142	0.097	0.101

EVAPOTRANSPIRATION

TOTALS	0.700	1.052	0.787	0.485	0.563	0.464
	0.267	0.199	0.333	0.302	0.448	0.536
STD. DEVIATIONS	0.141	0.394	0.512	0.241	0.431	0.323
	0.168	0.045	0.235	0.183	0.296	0.167

PERCOLATION FROM LAYER 8

TOTALS	0.0604	0.0547	0.0595	0.0571	0.0585	0.0562
	0.0576	0.0571	0.0548	0.0561	0.0539	0.0552
STD. DEVIATIONS	0.0225	0.0206	0.0225	0.0218	0.0225	0.0217
	0.0224	0.0223	0.0215	0.0221	0.0213	0.0219

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 79 THROUGH 88

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	7.08	(2.085)	25715.	100.00
RUNOFF	0.391	(0.336)	1418.	5.51
EVAPOTRANSPIRATION	6.137	(1.351)	22277.	86.63
PERCOLATION FROM LAYER 8	0.6813	(0.2626)	2473.	9.62
CHANGE IN WATER STORAGE	-0.125	(0.890)	-453.	-1.76

****

****

PEAK DAILY VALUES FOR YEARS 79 THROUGH 88

	(INCHES)	(CU. FT.)
PRECIPITATION	0.93	3375.9
RUNOFF	0.449	1630.7
PERCOLATION FROM LAYER 8	0.0029	10.4
SNOW WATER	0.75	2734.6

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2802
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

****

****

FINAL WATER STORAGE AT END OF YEAR 88

LAYER	(INCHES)	(VOL/VOL)
1	3.42	0.1424
2	4.81	0.0401
3	4.95	0.0412
4	5.00	0.0416
5	4.97	0.0414
6	4.90	0.0409
7	4.85	0.0404
8	4.85	0.0404
SNOW WATER	0.00	

****
****

MEMORANDUM

TO: Larry Bennett, MW Boise
Pam Ankrum, MW Richland
Project File

October 29, 1993

FR: Frank Shuri, GAI Redmond

RE: SURFACE WATER AND LEACHATE MANAGEMENT AT COMMERCIAL WASTE FACILITIES, Job No. 923-A024

Facility: Chemical Waste Management of the Northwest
Arlington, Oregon Facility

Contact: Ms. Nancy Proctor
(503) 454-2643

Landfill L-13 produces about 50,000 to 100,000 gallons of leachate annually. The landfill area at the ground surface [i.e., the catchment area for leachate] is 19 acres.

[Landfill L-13 is about 60 feet below ground surface and is presently being filled above grade.]

arlngtn2.w51

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX D

INTERIM COVER COSTS

THIS PAGE INTENTIONALLY
LEFT BLANK

Golder Associates	SUBJECT Leachate Treatment Costs		
	Job No. 923-E046	Made by FSS	Date 11-4-93
	Ref. ERDF	Checked	Sheet 1 of 2
		Reviewed	

① Per Mike Casbon (WHC):

W-018 Wastewater Treatment Plant: $18,000,000 capital cost
300 GPM
20 year life
Operates 8 hrs/day, 365 days/year
Total O+M costs: $44,900,000

Annual Volume:

$300 \text{ gal/min} \times 60 \text{ min/hr} \times 8 \text{ hrs/day} \times 365 \text{ days/yr} = 5.26 \times 10^7 \text{ gal/yr}$

Annual Cost:

Capital (simple amortization): $\$18,000,000/20 = \$900,000/\text{yr}$

$$\frac{\$900,000/\text{yr}}{5.26 \times 10^7 \text{ gal/yr}} = \$0.017/\text{gal}$$

$$\text{Operating}: \frac{\$44,900,000/20 \text{ yrs}}{5.26 \times 10^7 \text{ gal/yr}} = \$0.043/\text{gal}$$

Total: $0.06/gal

② Per Chris Cain – Montgomery Watson
Walnut Creek, CA
(510) 975-3400
10-26-93
Specialists in wastewater treatment plant design

Use reverse osmosis to remove radionuclides, send treated effluent to evaporation pond. Reverse osmosis will give "high end" of costs.

Reverse osmosis: Rule of thumb for treatment plant:

$$\$2000/\text{acre-ft} \times \frac{1 \text{ acre}}{43560 \text{ ft}^2} \times \frac{1 \text{ ft}^3}{7.48 \text{ gal}} = \$0.01/\text{gal}$$

Golder Associates	SUBJECT Leachate Treatment Costs		
	Job No. 923-E046 Ref. ERDF	Made by FSS Checked Reviewed	Date 11-4-93 Sheet 2 of 2

Rule of Thumb:

Sewage Treatment Plant Costs: \$2-\$4 per 1000 gal

(includes both capital + O&M)

Assume higher costs for small plant, remoteness of Hanford Site:

Say \$10/1000 gal = \$0.01/gal

Golder Associates	SUBJECT Low-Permeability Interim Cover Costs		
	Job No. 923-E046	Made by FSS	Date 11-4-93
	Ref. ERDF	Checked / Reviewed	Sheet 1 of 3

① Asphalt –

Means 025 104 0460:

Asphalt Concrete, wearing course, 3" thick: \$5.80/yd²

025 122 0100: Fine grade large area: \$0.57/yd²

Total: \$6.37/yd²

= \$0.71/ft²

Consider remoteness of site, Hanford requirements + constraints: allow factor of 2

2 x \$0.71/ft² = \$1.42 say $\boxed{\$1.50/ft^2}$

② Geomembrane –

Assume VLDPE, 20-mil

Installed cost: \$0.25/ft² based on experience

Apply factor as above: \$0.25/ft² x 2 = $\boxed{\$0.50/ft^2}$

Sheet 2 of 3

2 SITE WORK

024 | Railroad and Marine Work

024 880 | Docks & Facilities

		024 880 Docks & Facilities	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1993 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
892	0200	Treated piles, not including mobilization									
	0210	50' long, 20 lb. creosote, shore driven	B-19	540	.119	V.L.F.	8.75	2.81	2.46	14.02	17
	0220	Barge driven	B-76	320	.225		8.75	5.35	5.75	19.85	25
	0230	2.5 lb. CCA, shore driven	B-19	540	.119		7.75	2.81	2.46	13.02	15.90
	0240	Barge driven	B-76	320	.225		7.75	5.35	5.75	18.85	24
	0250	30' long, 20 lb. creosote, shore driven	B-19	540	.119		6	2.81	2.46	11.27	13.95
	0260	Barge driven	B-76	320	.225		6	5.35	5.75	17.10	22
	0270	2.5 lb. CCA, shore driven	B-19	540	.119		4.25	2.81	2.46	9.52	12.05
	0280	Barge driven	B-76	320	.225		4.25	5.35	5.75	15.35	19.90
	0300	Mobilization, barge, by tug boat	B-83	25	.640	Mile		13.65	19.30	32.95	42
	0350	Standby time for shore pile driving crew				Hr.				365	
	0360	Standby time for barge driving rig								450	

025 | Paving and Surfacing

025 100 | Walk/Rd/Parkng Paving

		025 100 Walk/Rd/Parkng Paving	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1993 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
104	0010	ASPHALTIC CONCRETE PAVEMENT for highways R025-110									
	0020	and large paved areas									
	0080	Binder course, 1-1/2" thick	B-25	7,725	.011	S.Y.	2	.23	.21	2.44	2.79
	0120	2" thick		6,345	.014		2.67	.28	.25	3.20	3.65
	0160	3" thick		4,905	.018		3.95	.36	.33	4.64	5.25
	0200	4" thick		4,140	.021		5.30	.43	.39	6.12	6.90
	0300	Wearing course, 1" thick	B-25B	10,575	.009		1.44	.19	.17	1.80	2.06
	0340	1-1/2" thick		7,725	.012		2.19	.26	.24	2.69	3.07
	0380	2" thick		6,345	.015		2.95	.31	.29	3.55	4.04
	0420	2-1/2" thick		5,480	.018		3.63	.36	.33	4.32	4.93
	0460	3" thick		4,900	.020		4.33	.40	.37	5.10	5.80
	0800	Alternate method of figuring paving costs									
	0810	Binder course, 1-1/2" thick	B-25	630	.140	Ton	26	2.83	2.54	31.37	36
	0811	2" thick		690	.128		26	2.58	2.32	30.90	35.50
	0812	3" thick		800	.110		26	2.23	2	30.23	34.50
	0813	4" thick		900	.098		26	1.98	1.78	29.76	34
	0850	Wearing course, 1" thick	B-25B	575	.167		26.50	3.43	3.17	33.10	38.50
	0851	1-1/2" thick		630	.152		26.50	3.13	2.90	32.53	37.50
	0852	2" thick		690	.139		26.50	2.86	2.64	32	37
	0853	2-1/2" thick		745	.129		26.50	2.65	2.45	31.60	36.50
	0854	3" thick		800	.120		26.50	2.47	2.28	31.25	36
108	0010	ASPHALTIC CONCRETE At the plant (145 lb. per C.F.) R025-110				Ton	25.50			25.50	28.50
	0200	All weather patching mix					27.50			27.50	30.50
	0300	Berm mix					27.50			27.50	30.50
	0400	Base mix					25.50			25.50	28.50
	0500	Binder mix					25.50			25.50	28.50
	0600	Sand or sheet mix					27.50			27.50	30.50
	2000	Reclaimed pavement in stockpile					9.55			9.55	10.50
	2100	Recycled pavement, at plant, ratio old: new, 70:30					19			19	21
	2120	Ratio old: new, 30:70					23.50			23.50	26
112	0010	CALCIUM CHLORIDE Delivered, 100 lb. bags, truckload lots				Ton	300			300	330
	0200	Solution, 4 lb. flake per gallon, tank truck delivery				Gal.	.62			.62	[illegible]

See the Reference Section for reference number information, Crew Listings and City Cost Indexes

025 | Paving and Surfacing

025 100 | Walk/Rd/Parkng Paving

			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1993 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
116	0010	COLD LAID ASPHALT PAVEMENT 0.5 gal. asphalt/S.Y. per in. depth										116
	0020	Well graded granular aggregate										
	0100	Blade mixed in windrows, spread & compacted 4" course	B-90A	1,600	.035	S.Y.	3.60	.77	.98	5.35	6.25	
	0200	Traveling plant mixed in windrows, compacted 4" course	B-90B	3,000	.016		3.60	.35	.46	4.41	5	
	0300	Rotary plant mixed in place, compacted 4" course	•	3,500	.014		3.60	.30	.39	4.29	4.85	
	0400	Central stationary plant, mixed, compacted 4" course	B-36	7,200	.006		7.20	.12	.16	7.48	8.25	
120	0010	CONCRETE PAVEMENT Including joints, finishing, and curing										120
	0020	Fixed form, 12' pass, unreinforced, 6" thick	B-26	3,000	.029	S.Y.	13.50	.61	.60	14.71	16.45	
	0030	7" thick		2,850	.031		15.75	.64	.63	17.02	19.05	
	0100	8" thick		2,700	.033		18	.68	.66	19.34	21.50	
	0200	9" thick		2,900	.030		20.50	.63	.62	21.75	24	
	0300	10" thick		2,100	.042		22.50	.87	.85	24.22	27.50	
	0400	12" thick		1,800	.049		27	1.02	1	29.02	32	
	0500	15" thick		1,500	.059		34	1.22	1.20	36.42	40	
	0510	For small irregular areas, add						100%		100%		
	0600	For continuous welded steel reinforcement over 10' wide, add				S.Y.				4.30		
	0610	Under 10' wide, add								6.45		
	0700	Finishing, broom finish small areas	2 Cefi	135	.119			2.73		2.73	4.08	
	0730	Transverse expansion joints, incl. premolded bit. jt. filler	C-1	150	.213	L.F.	1	4.73	.16	5.89	8.70	
	0740	Transverse construction joint using bulkhead	•	73	.438	•	1.45	9.70	.34	11.49	17.20	
	0750	Longitudinal joint tie bars, grouted	B-23	70	.571	Ea.	2.25	10.85	8.20	21.30	28.50	
	1000	Curing, with sprayed membrane by hand	2 Clab	1,500	.011	S.Y.	.15	.20		.35	.48	
	1650	For integral coloring, see div. 033-126										
	3000	Cold planing incl. cleaning, 1-1/2" thick	B-32	170	.188	S.Y.		4.27	9.50	13.77	17	
122	0010	FINE GRADE Area to be paved with grader, small area	B-11L	800	.020			.43	.70	1.13	1.43	122
	0100	Large area	•	2,000	.008			.17	.28	.45	.57	
	0200	Grade subgrade for base course, roadways	B-32B	17,000	.001			.03	.07	.10	.13	
	0300	Fine grade, base course for paving, see div. 022-308										
	1020	For large parking lots	B-32C	5,000	.010	S.Y.		.21	.32	.53	.67	
	1050	For small irregular areas		2,000	.024			.52	.81	1.33	1.69	
	1100	Fine grade for slab on grade, confined area, machine		1,500	.032			.69	1.08	1.77	2.25	
	1150	Hand grading	B-18	700	.034			.66	.06	.72	1.10	
	1200	Fine grade granular base for sidewalks and bikeways	B-63	2,000	.020			.39	.05	.44	.66	
	3000	Hand grade select gravel, including compaction, 4" deep	B-18	555	.043			.83	.08	.91	1.39	
	3100	6" deep		400	.060			1.15	.11	1.26	1.93	
	3120	8" deep		300	.080			1.54	.15	1.69	2.53	
	3300	Finishing grading slopes, gentle	B-11L	8,900	.002			.04	.06	.10	.13	
	3310	Steep slopes	•	7,100	.002			.05	.08	.13	.16	
128	0010	SIDEWALKS, DRIVEWAYS, & PATIOS No base										128
	0020	Asphaltic concrete, 2" thick	B-37	720	.067	S.Y.	2.95	1.31	.17	4.43	5.50	
	0100	2-1/2" thick	•	660	.073	•	3.63	1.43	.19	5.25	6.40	
	0110	Bedding for brick or stone, mortar, 1" thick	D-1	300	.053	S.F.	.21	1.14		1.35	2	
	0120	2" thick	•	200	.080		.45	1.72		2.17	3.15	
	0130	Sand, 2" thick	B-18	8,000	.003		.07	.06	.01	.14	.18	
	0140	4" thick	•	4,000	.006		.15	.12	.01	.28	.36	
	0300	Concrete, 3000 psi, cast in place with 6 x 6 - W1.4 x W1.4 mesh,										
	0310	broomed finish, no base, 4" thick	B-24	600	.040	S.F.	.92	.87		1.79	2.35	
	0350	5" thick		545	.044		1.10	.95		2.05	2.68	
	0400	6" thick		510	.047		1.28	1.02		2.30	2.98	
	0440	For other finishes, see Div. 033-450										
	0450	For bank run gravel base, 4" thick, add	B-18	2,500	.010	S.F.	.12	.18	.02	.32	.44	
	0520	8" thick, add	•	1,600	.015		.24	.29	.03	.56	.74	
	0550	Exposed aggregate finish, add to above, minimum	B-24	1,875	.013		.06	.28		.34	.50	
	0600	Maximum		455	.053		.21	1.14		1.35	1.99	
	0700	Patterned surface, add to above min.		1,200	.020			.43		.43	.67	
	0710	Maximum		500	.048			1.04		1.04	1.60	

SITE WORK 2

THIS PAGE INTENTIONALLY
LEFT BLANK